REPORT OF

Seventeenth Annual

Date Growers' Institute

APRIL 13, 1940

HELD IN

COACHELLA VALLEY

CALIFORNIA

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THE DATE INSTITUTE
P. O. Box 565 Indio, California

Seventeenth Annual Date Growers' Institute

Saturday, April 13, 1940

MORNING SESSION

Chairman, Frank A. Thackery, Indio, California

May I first express to you my sincere appreciation of the honor of presiding at the morning session of this, the 17th Annual Date Growers Institute. It has been my privilege to attend practically every one of the previous sixteen Date Growers Institutes. It is encouraging to note the progress made from year to year. I am confident that much good has come and will continue to come from these Date Institutes.

The present status in the successful establishment of this new and important horticultural industry has been accomplished very largely by the date growers' ability and perseverance in meeting and conquering many unforeseen difficulties. I would like especially to emphasize the importance to the American date growing industry of the persistence and splendid courage which has been so frequently manifested by the pioneer and other date growers of our southwest. It appears that every new and important agricultural or horticultural industry is called upon to experience many trials and tribulations. Certainly the date growing industry of the United States has had its full share.

I am confident, however, that a continuance of this persistence and splendid courage will eventually be crowned with satisfactory success. The difficulties which we have experienced to date enables us to build a broader, more permanent and successful foundation for the future success of the industry.

It seems to me that our date growers may be said to have successfully met the supreme test when their persistence and courage brought them through the serious difficulties incident to the rains of September, 1939. Although the average rainfall for the month of September over a sixty year period shows approximately one fifth of an inch, September, 1939, recorded about 8.96 inches.

Perhaps the persistence and courage of our date growers is partially explained when we remember that the annual per capita consumption of dates in the United States is approximately one half pound or a total of about 63,000,000 pounds of which no less than 50,000,000 pounds are imported each year. We certainly have an opportunity here both to increase our per capita consumption and to lessen the amount imported each year. I might remind you that the records show that the annual per capita consumption of dates in Canada is approximately one pound per capita. I believe also that it is generally conceded that our home grown product is superior in quality and preparation for market than the imported product. I believe that an extension of the beneficial uses of our sub-standard dates will prove more and more helpful to our American date growing industry.

May I suggest also that we might well give more time and thought to the importance to the date industry of increasing tourists into the date growing regions. I am sure that the well kept date gardens constitute one of the major tourist attractions. I believe much good would result to all business and other interests of the date growing localities if we would devise some means of coordinating the active interest of every citizen in attracting more tourists. Properly handled the tourists will do a lot of important advertising for us in addition to making small and large investments in our localities.

Relation of Water Supply by the Date Palm to Water Injury of the Fruit

By W. W. Aldrich, Senior Horticulturist, and D. C. Moore, Scientific Aide, U. S. Bureau of Plant Industry, Indio, California

WATER injury to date fruit apparently results from excessive hydration (water intake) of the flesh or skin. Such excessive hydration may immediately injure the fruit by causing a break in the skin or by interfering with the normal dehydration incident to ripening. For this discussion, the immediate water injury will be classified into four types:

1. Checking and Blacknose.
2. Splitting (also called tearing).
3. Excessive Hydration without Splitting.
4. Calyx Loosening.

Injuries due to fungi or other microorganisms following excessive hydration will be discussed by others.

Checking and Blacknose

Checking of Deglet Noor, which if severe develops into blacknose, is the result of water injury to fruit during mid-summer, when the fruit color is changing from green to the first tints of pink. A growth curve for fresh weight of Deglet Noor fruit (pollinated about March 19, 1939) in the Indian Wells district, is shown in figure 1. The degree of susceptibility of the fruit to checking, determined by C. L. Crawford by noting the percentage of fruits developing and checking after immersion of detached fruits in water for two hours, is indicated by the height of the cross-hatched area under the dotted line. The susceptibility to checking began in June and ceased in early August, just before the maximum fruit size was attained and at about the time when the most rapid increase in dry matter (principally sugars) began. These observations for 1939, based on weekly samples, agree in a general way with the results obtained by Haas and

Bliss (1) in 1932, using samples obtained every three weeks.

Checking has been observed to occur in early morning following a night of high (maximum of 78 percent) relative humidity without rain. Although this checking may in part be due to absorption of water vapor through the skin of the fruit, recent will occur. If a fruit has cells susceptible to rupturing by excessive hydration, checking may occur. This theory seems to have been substantiated by experiments in 1938 and in 1939.

Irrigations during July were omitted until the palms showed (by reduced rate of leaf elongation) that gations also resulted in about 10 percent smaller fruit and about one week earlier ripening of the fruit. Complete grade records in 1939 were prevented by the rains. Therefore, the omission of irrigation is not recommended at the present time as a practical method of minimizing checking and blacknose.

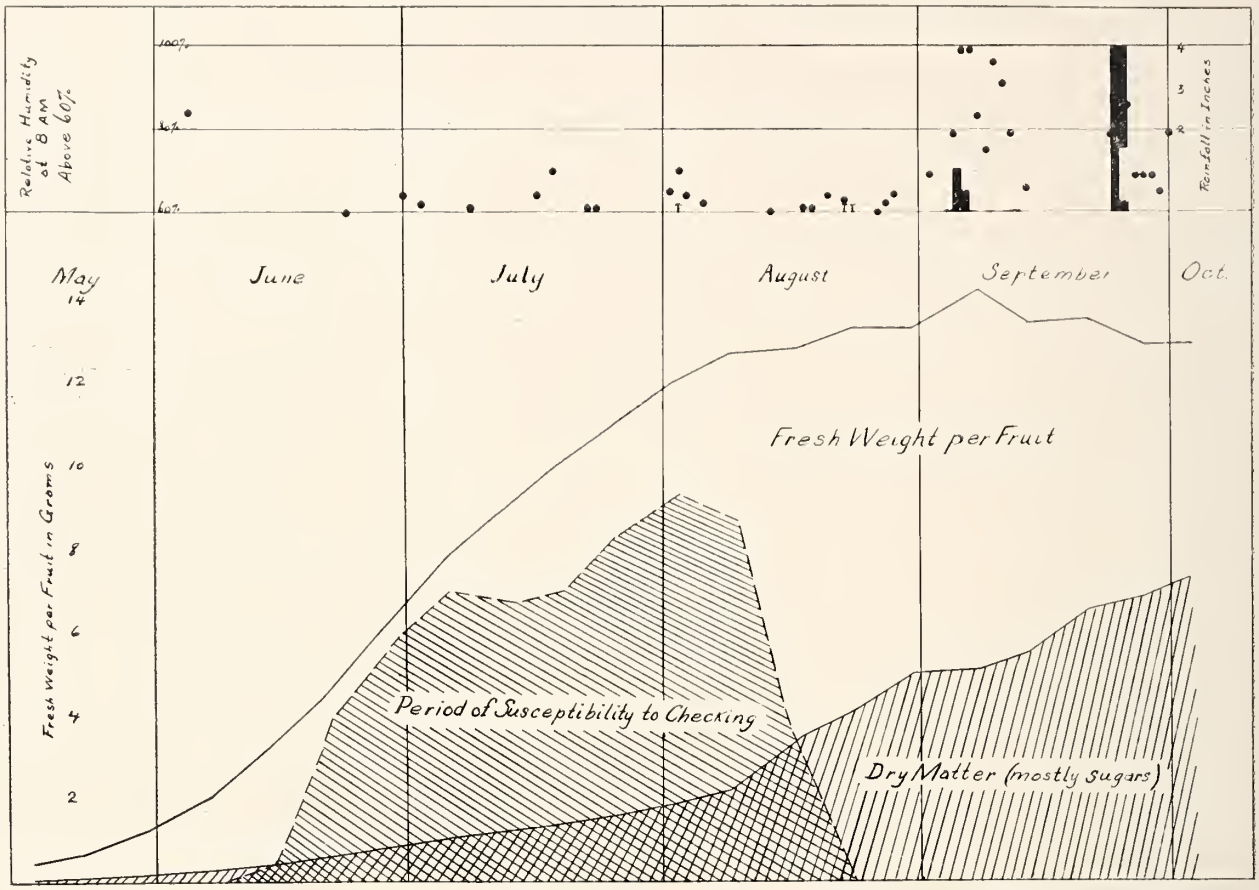

Figure 1.—Growth curves of fresh weight and dry matter of Deglet Noor fruit pollinated about March 19, 1939. Period of susceptibility of fruit to checking is shown by area under dotted line. Black dots show relative humidity at 8 a. m. when this relative humidity was 60 percent or more. Black rectangular areas indicate amount of rainfall.

research on Deglet Noor, as well as results by Verner (3) on apples, indicates that water supplied to the fruit by the palm may be involved.

Date fruits shrink considerably during the day, but regain their volume during the night. This indicates that during the day the rate of evaporation of water from the leaves and fruits is sufficient to reduce the water content of the fruits, but during the night this evaporation is less and the fruits regain water. However, during a night of high relative humidity the rate of evaporation of water from the leaves and fruits may be so slow that the water intake by the roots will be enough to keep an abnormally high amount of water in the palm, and then excessive hydration of the fruit the water supply in the palm was reduced during late July and early August, as compared with the palms with the regular ten-day irrigation. This was the period in both 1938 and 1939 when Deglet Noor fruits were most susceptible to checking.

In every experiment the percentage of fruits developing checking and also blacknose was less for the palms with reduced water supply than for palms with the regular, 10-day irrigations. Thus reducing the water supply from the palm to the fruits reduced, but did not entirely prevent, this type of water injury to the fruit. However, in addition to reducing the checking and blacknose, the reduced water supply in the palm following the omission of irri-

Splitting

Splitting (also called tearing) is the type of water injury caused by excessive hydration of the fruit in the khalal or preripe stages. For Deglet Noor the fruit is susceptible to splitting from the stage when checking ceases to the stage when complete fruit softening occurs. The fruits, whose growth curve is shown in figure 1, were severely injured by the rain and high relative humidity during the September 4-12 period. By September 12 about 26 percent of the fruits showed the typical, irregular cracking, and about 19 percent additional fruits had the skin loosened and curled to some extent. A few of these fruits had deep ruptures with the flesh exposed. Following the heavy rain of September 24,

some additional fruits were split. The injury by fungi was not estimated. No experimental plots of Deglet Noor had reduced water supply during this September 4 - 12 period; so the effect of reduced water supply upon fruit splitting could not be measured.

Whereas the 1939 date loss from splitting was the greatest in the history of the relatively young date industry in the United States, considerable loss from splitting has occurred before. For the 15-year period from 1925 to 1939, inclusive, the notes of Roy W. Nixon show serious Deglet Noor fruit splitting following August, September or October rains in 1925, 1927, 1929 and 1931, as well as in 1939. Thus in 5 out of 15 years, or in one third of the past 15 seasons, rain has caused serious amount of splitting. However, the early losses would have probably been much less serious if the current practice of bagging had been in general use at that time.

Excessive Hydration Without Splitting

The excessive hydration of fruit without splitting is illustrated by the hump on September 7, in the fresh weight line in figure 1. This hump can be explained by the changes in total water per fruit for weekly periods, which were:

Loss of 7 percent of water — August 23 to August 30

Increase of 6 percent of water — August 30 to September 7

Loss of 12 percent of water — September 7 to September 13

Loss of 11 percent of water — September 13 to September 20.

The weekly losses in water per fruit before and after the August 30 to September 7 period were probably about normal for khalal fruit, but the 6 percent increase in water during the August 30 to September 7 period was undoubtedly a manifestation of excessive hydration caused by the rain and high relative humidity on September 4, 5, and 6. Inasmuch as rate of leaf elongation, which frequently increases following an irrigation, increased during the September 4 to 6 period, it seems quite likely that this excessive hydration of fruit without splitting was at least in part due to increased water supply from the palm.

Not only did such excessive hydration of Deglet Noor, as well as of other varieties, necessitate special handling of the fruit to render it suitable for storage; but the excessive hydration seemed to be responsible for a darkening of the color and a loss in flavor of the ripened fruit. For such varieties as Zahidi and Gondeila, this hydration improved the flavor.

Calyx Loosening

Loosening of the fruit from the calyx (or perianth) was another type of water injury in 1939. However, it is possible that the loosening was a result of fungi following the excessive hydration rather than being a direct result of the hydration.

In experimental plots with Saidy, palms without irrigation during late August and early September showed (by reducing rate of leaf elongation) reduced water supply in the palm as compared with adjacent palms irrigated every 10 days. During the September 4-12 period of rain and high relative humidity, only 2 percent of the fruits dropped from the palms with reduced water supply, while 14 percent dropped from the palms irrigated every 10 days. This result which was similar to casual observations in 1930, indicates that calyx loosening of Saidy was reduced by a reduced water supply from the palm to the fruit.

Other Factors Affecting Water Injury to Fruit

Nixon (2) has reported that heavy fruit thinning of Deglet Noor resulted in more checking and blacknose than medium or light thinning. Recently Nixon has observed that reducing the number of bunches per palm to give as many as 10 to 15 leaves per bunch resulted in more checking and blacknose. These and other results indicate that some condition within the fruit other than water supply may also greatly affect the susceptibility of the fruit to water injury.

Summary

Water injury to date fruit following a period of rain or high relative humidity seems to be influenced by the water supply from the palm to the fruit, as well as by water absorbed directly from the air through the skin of the fruit. Reducing water supply from the palm to the fruit at certain times by the omission of irrigations was found to reduce the checking of Deglet Noor and the calyx loosening of Saidy. However, because of possible undesirable effects of reducing the water supply in the palm, the omission of irrigation is not at present recommended as a practical method of minimizing either the checking and blacknose of Deglet Noor or the calyx loosening of Saidy.

* * *

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Structural and Chemical Factors In Relation to Fungus Spoilage of Dates*

By F. M. Turrell, W. B. Sinclair and D. E. Bliss, University of California Citrus Experiment Station, Riverside, California

INTRODUCTION

FROM the commercial standpoint, fruit spoilage due to micro-organisms constitutes the most important group of date diseases in California. The sugary nature of the ripening fruit makes it peculiarly susceptible to fungus attack during periods of rainy or humid weather. In considering the amount of loss from fruit spoilage which occurs in any season, it is difficult to segregate that due primarily to water injury (checking and tearing) from that which is caused by fungi. All the fungi which are known to cause spoilage in dates will enter the ruptures in the rind of the fruit which are associated with water injury. Under favorable conditions certain of these fungi are also capable of penetrating unwounded fruit surfaces.

Unusually severe losses from fruit

*Paper No. 415, University of California Citrus Experiment Station and Graduate School of Tropical Agriculture, Riverside, California.

spoilage were encountered in the Coachella Valley in September, 1939, as the result of two heavy rainstorms.** According to packing-house estimates, the tonnage of dates was reduced by spoilage from about 11 million pounds to less than 4 million pounds. It may be estimated roughly that one half of the loss was caused by water injury and the other half by fungus decay.

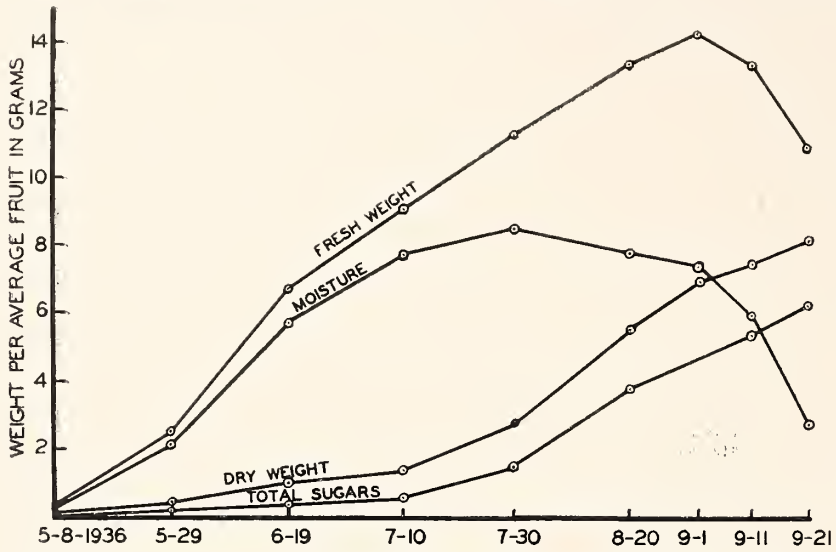

Fig. 1.—The change in fresh weight, moisture, dry weight, and total sugars of an average Deglet Noor date fruit (in grams) determined on samples picked during the growth period.

Studies on the fungus spoilage of dates reported in this paper were begun in 1931. In 1938 a formal project was organized in the Agricultural Experiment Station of the University of California for the purpose of developing methods to reduce the losses from fungus fruit spoilage.

In this preliminary paper, the writers wish to report certain studies on the general nature of fungus fruit spoilage, on that type of calyx-end rot which is caused by Aspergillus niger, V. Tiegh. and on side spot decay as caused by Alternaria sp. These investigations were made on fruits of the Deglet Noor variety which were taken in different stages of maturity from palms in the Coachella Valley.

GENERAL NATURE OF FUNGUS FRUIT SPOILAGE

Unlike the green plants, fungi must obtain their food from sources of elaborated organic matter. Analyses made by Haas and Bliss (7) showed some of the changes in chemical composition of the date fruit during its period of growth. We have repeated and confirmed some of these analyses and the results are shown in figure 1.

The concentrations of moisture and sugar during the growth period of the fruit (Fig. 1) make the pulp a favorable medium for fungus growth for a considerable length of time. However, unless the fruit is wounded and the pulp exposed, the period of susceptibility to fungus attack is relatively short.

The curve in figure 2 shows the relation of the stage of fruit maturity to susceptibility to fungus spoilage. This curve is a graphical representation of our ideas of the relative susceptibility of the fruit at different stages of maturity, based on several years of study in the field and laboratory. Although the curve is not drawn on numerical values, it is thought to present a rather accurate picture.

It is not possible to associate closely the time of year and the stage of maturity of the fruit, because not all the date fruits ripen at the same time. In the same fruit bunch there may be as much as six weeks difference in the time of maturity of different fruits.

In figure 2 it may be seen that the period of susceptibility falls mostly within the khalal and rutab stages*** of maturity. Except in the tamar stage, the moisture and sugar concentrations (Fig. 1) appear to be favorable to fungus growth. These facts give rise to the three following questions: (1) What factors prevent infection during the kimri stage? (2) What changes occur to permit infection during the khalal and rutab stages? (3) What factors make the tamar stage unsuited for fungal growth?

CAUSES OF FUNGUS FRUIT SPOILAGE

In 1920, Brown (1) concluded that Alternaria was the primary cause of

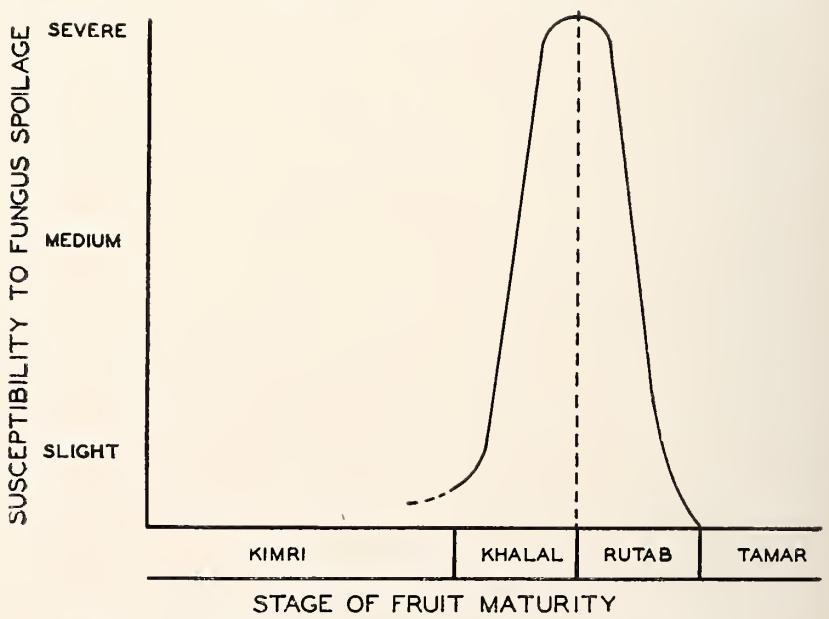

Fig. 2.—The relationship between the stage of maturity and susceptibility to fungus spoilage of Deglet Noor date fruit.

**Data supplied through the courtesy of Dewey C. Moore, U. S. Department of Agriculture, show 8.96 inches precipitation at the U. S. Experiment Date Garden, Indio, California, during the month of September, 1939.

***Stages of maturity in Deglet Noor date fruit are: "kimri," turgid and green; "khalal," turgid and red; "rutab," partially softened to completely softened and reddish to brownish; "tamar," softened, brownish, and cured to point where the fruit will keep.

rot and mummification of dates in Arizona. Aspergillus and Penicillium species were thought to follow Alternaria and cause further disintegration of the pulp. He later added Macrosporium, Helminthosporium, Macrophoma and bacteria to the list of spoilage organisms found in Arizona (Brown 2, 3). Fawcett and Klotz (5) found essentially the same kinds of fungi on date fruits in California.

In our investigations, at least 20 species of fungi and several forms of yeasts and bacteria have been cultured from naturally infected dates of the Deglet Noor variety. Of these fungi, 12 species belong to the genus Aspergillus; the others have been identified, tentatively, as forms of Alternaria, Stemphylium, Penicillium, Cladosporium, Curvularia and Diplodia. From the economic standpoint, fungi of the Aspergillus niger group and those of the Alternaria group (including Stemphylium) are by far the most important agents of fungus fruit spoilage in the Coachella Valley.

In this paper, discussion will be confined to Aspergillus niger and Alternaria sp. (similar to A. citri Pierce (5)). Aspergillus niger is typical of those fungi which cause calyx-end rot of dates, while Alternaria sp. is representative of those fungi which cause side spot decay.

As has been indicated, the date would be a favorable substrate for fungi if it were not for certain protective mechanisms inherent in the fruit. These mechanisms may be structural or chemical. An example of the structural protective mechanism in another fruit may be found in the work of Valleau (11) on the brown rot of plums (Sclerotinia) where a correlation is shown between disease resistance and the thickness of the skin. A type of chemical protective mechanism may be illustrated by the work of Link, Angell, and Walker (8) and of Link and Walker (9) who demonstrated that certain substances related to tannins (protocatechuic acid and catechol) are associated with the red pigment in the outer scales of the red onion. These substances, which are responsible for the resistance of the red onion to smudge disease (Colletotrichum circinans), are not present in the outer scales of the susceptible white onion. The Deglet Noor date has a relatively thick skin which contains tannin-like substances.**** Resistance of this date to fungal attack may therefore be due to both structural and chemical factors.

CALYX-END ROT

The most common type of fungus fruit spoilage of Deglet Noor dates in the Coachella Valley is the calyx-end rot caused by Aspergillus niger, the black mold commonly found in spoiled dates. The fungus body (Fig. 3) is composed of branched, thread-like hyphae (mycelium) and stalked spore-bearing heads. Each stalk produces thousands of microscopic black bodies (spores) which are widely disseminated in the soil and in the air. New colonies of the mold are produced following the germination of these spores.

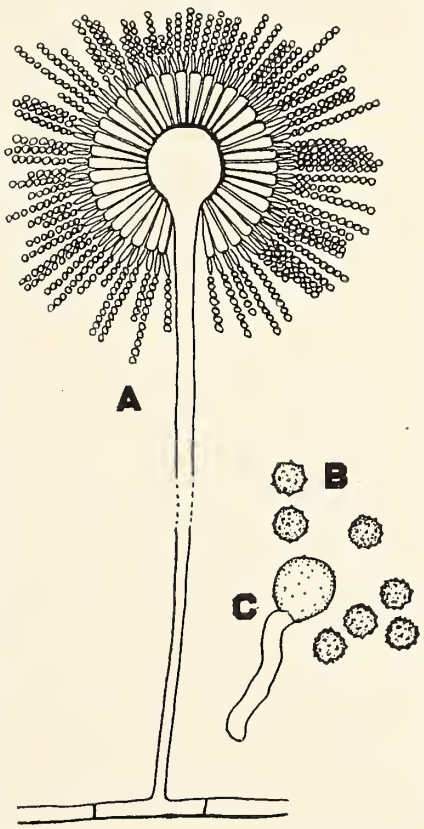

Fig. 3.—Aspergillus niger. A, spore-bearing stalk with finger-like branches and chains of spores radiating from a globose swelling at the end; B, spores showing roughened surfaces; C, a germinating spore.

In the kimri stage, tears which penetrate deeply into the flesh of the date are uncommon and the fruit is not often injured by Aspergillus niger. However, dates in the late kimri stage, when deeply wounded by artificial means, are subject to a mild form of rot. Usually the first evidence of Aspergillus niger is to be found on the edges of the calyx lobes. As already indicated in figure 2, the fruit is most susceptible in the khalal and rutab stages and is resistant in the later tamar stage.

During most of the susceptible period, the Deglet Noor fruit is subject to the attack of Aspergillus niger through wounds at any point on the surface. In the absence of wounds, this fungus gains entrance to the fruit in the region beneath the calyx but apparently cannot penetrate the surface of the fruit elsewhere.

The tissues on the under side of the calyx lobes, beneath the calyx on the fruit surface, and those connecting the calyx and fruit proper are markedly different from the tissues of the exposed portion of the fruit. At the equator of the date, as shown in figure 4A, there is an outer waxy layer called the cuticle. Below this is a single layer of cells (epiderm) having thick outer walls. There are four layers of small, thin-walled cells below the epiderm, called the hypoderm. A very discontinuous and irregular layer of extremely thick-walled cells (stone cells) come next. Separated from this layer by thin-walled cells are two or three layers of giant cells containing tannin. The remainder of the pulp is composed of relatively thin-walled, succulent cells. In figure 4C the position of the true tannin layer is shown in relation to the general conformation of the date.

The newly forming tissue at the junction of the calyx and the fruit is undifferentiated (Fig. 4B). Regardless of the structure that these cells assume when mature, they are at first thin-walled and unprotected by a cuticle. Tannin-bearing cells differentiate early near the growing region, where they are very close to the surface, while at points farther removed they are deeply situated.

The thicknesses of the different tissues beneath the calyx, at a point where the stone cells are well differentiated, and the thicknesses of the tissues at the equator of the fruit are given in table 1. There seems to be a significant thickening of the cuticle and of the outer wall of the epiderm during the maturation of the cells to form tissues.

The actual penetration of Aspergillus niger through the outer epidermal wall of the fruit or calyx has not been observed. However, the

****For the purposes of this discussion we shall divide tannins into two groups, as suggested by Proctor (10). The first group, the true tannins or pyrogallol tannins, precipitate proteins or tan leather and are responsible for the astringent taste of kimri and khalal dates. The second group, consisting of the pyrocatechol tannins and related compounds, which do not precipitate protein or tan leather, will be referred to as tannin-like substances.

hyphal threads of the fungus have been seen in the epidermal and underlying cells of the fruit beneath the calyx. Also, the initial symptoms of calyx-end rot have been observed in this region following artificial inoculation, whereas no infection resulted on other portions of the fruit.

It has now been shown that (a) Aspergillus niger attacks the date through wounds which penetrate the cuticle and epiderm; (b) that it attacks the unwounded fruit in the region of the calyx where the cuticle is absent and the outer epidermal walls are not thickened; and (c) that conversely, it does not attack unwounded surfaces where the cuticle and epiderm are thickened. This appears to be a case of mechanical resistance, but in view of the fact that A. niger has the ability to excrete active substances called enzymes, there may be chemical substances in the surface layers of the date which inactivate these enzymes, a phenomenon which is already known to exist. However, Aspergillus is known to contain certain tannin-splitting enzymes, and this adds to the complexity of this phase of the problem. This subject is now under investigation.

There are various chemical substances in the interior of the date which might act as protective agents. Among these are the true tannins and related compounds, as indicated by different methods of assay, figure 5. It has been mentioned that the true tannins are largely localized in a tissue composed of giant cells, which is relatively far removed from the surface. Analyses of date-fruit pulp, taken in 1938, at different stages of development, showed that the concentration of true tannins (Fig. 5, curve 2), which are soluble in 40 per cent acetone and precipitated with cinchonine sulfate, varied from 2.48 per cent on June 3 to only a slight positive test on September 12. In the equatorial region, the epiderm and the first layer of the hypoderm gave positive tests for tannins or tannin-like substances with ferric chloride and other reagents. It appears from these investigations that the true tannins are present only in small amounts in the exposed surface layers, but positive tests for certain other substances related to the tannins have been obtained from these tissues. However, under the calyx, the epiderm and hypoderm have not given positive tests.

It was at first thought that the true tannins were responsible for the resistance of the date to fungal attack, and in order to simulate the conditions in the date, the true tannin, digallic acid, was used in synthetic media (Czapek's formula without ferric chloride) at concentrations from zero to 20 per cent. Fair to good growth of Aspergillus niger was obtained at all of these concentrations of digallic acid, the greatest of which was several times larger

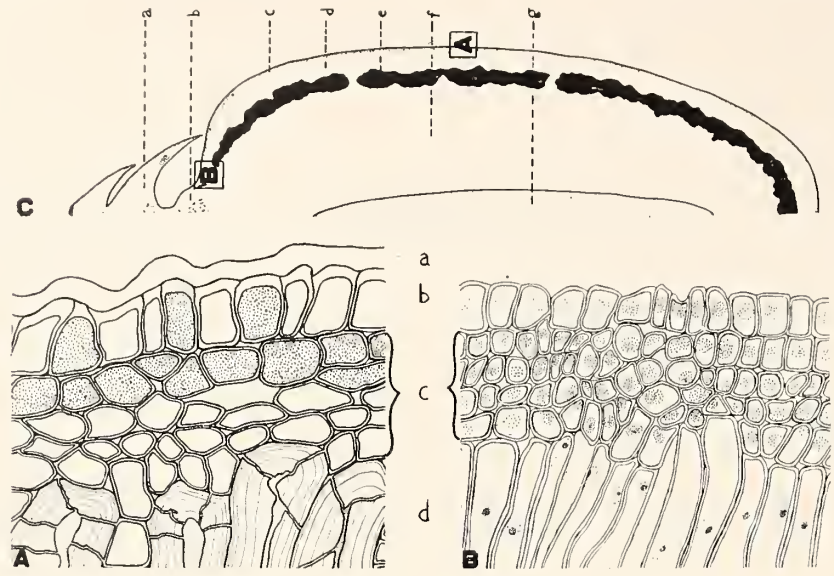

Fig. 4.—Longitudinal sections of a Deglet Noor date fruit:
A, at the equator, highly magnified; a, cuticle; b, epiderm; c, hypoderm; d, stone cells.
B, beneath calyx, same magnification as in A; cuticle absent; b, epiderm; c, hypoderm; d, stone cells.
C, one half of the fruit enlarged several times, showing the positions at which A and B were selected and the location of the principal tissues: a, calyx; b, growing region; c, epiderm, hypoderm, and stone cells; d, outer parenchyma; e, tannin layer; f, inner parenchyma; g, seed.

TABLE 1
Average thickness of outer tissues in large Deglet Noor date fruits (1.9 cm. in diameter) in microns.

Tissue	Beneath calyx	At equator
Cuticle	0.0	4.1
Epiderm	10.3	13.2
Hypoderm	23.7	39.2
Sclerenchyma	74.9	72.1
Outer parenchyma	46.5	557.7
Tanniferous layer	151.6	1386.8
Total	307.0	2073.0
Outer epidermal wall	0.3	3.2

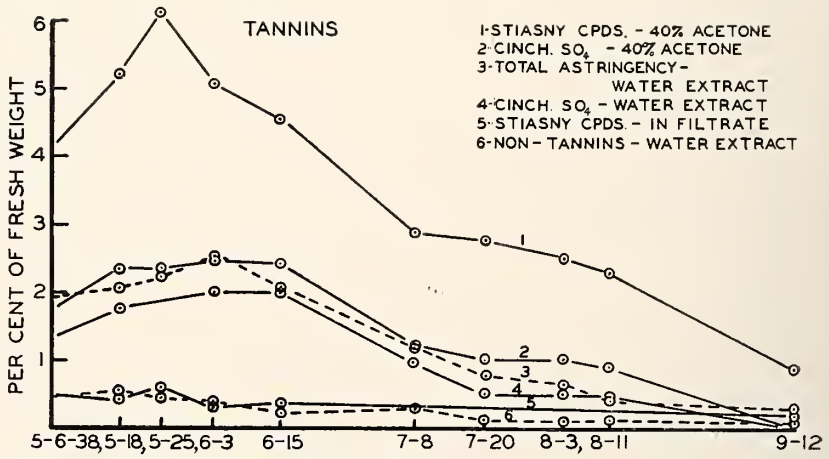

Fig. 5.—Curves representing the percentage concentration (fresh weight basis) of the tannins and tannin-like substances determined on Deglet Noor date samples picked at various stages of maturity: 1, Stiasny compounds, which represent true tannins (pyrogallol tannins) and tannin-like substances (pyrocatechol tannins); 2 and 4, cinchonine sulfate precipitates, which represent true tannins only; 3, potassium permanganate oxidizable compounds (expressed as digallic acid), which represent astringency.

than that found in the date. These results suggest that this type of tannin is not important in protecting dates from A. niger.

SIDE SPOT DECAY

The conditions which are conducive to calyx-end rot are somewhat different from those which cause side spot decay. Alternaria sp. (Fig. 6),

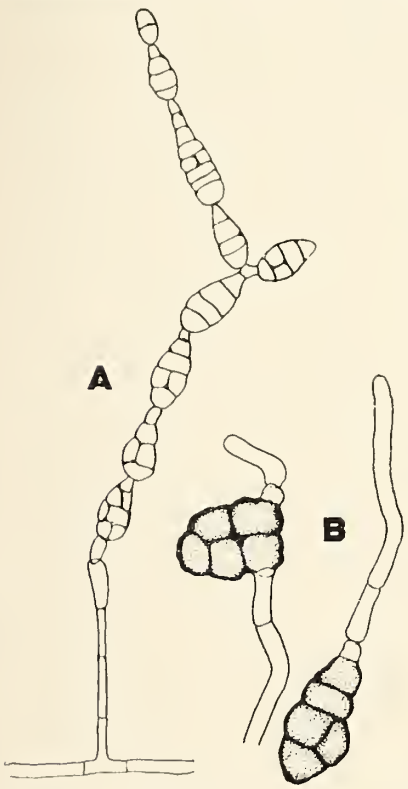

Fig. 6. — Alternaria sp.: A, spore-bearing stalk with a chain of spores; B, two germinating spores.

one of the fungi which cause side spots, differs from the calyx-end-rot organism in general appearance and in physiology. The fungus body of Alternaria consists of branched, creeping threads of mycelium, with simple, spore-bearing stalks. The spores are developed in chains. They are relatively large, club-shaped and contain considerable supplies of food. In contrast to Aspergillus niger, the spores of Alternaria sp. are capable of germination and of considerable mycelial growth without an accessory food supply. This characteristic may aid Alternaria in becoming established on the surface of the date. The spores have been found to germinate on the surface of dates in all stages of maturity except the tamar stage. Alternaria will attack wounded Deglet Noor fruits in the khalal and rutab stages, but direct penetration of unwounded fruits occurs only in the rutab stage. The side spot lesions which originate in the absence of wounds seem to be limited both in their period of development and in the region affected. These lesions when first visible are usually situated in the turgid, unripened portion of the fruit but within a distance of one or two centimeters from the advancing margin of the translucent tissue. Depending on the particular stage of maturity, side spot lesions may occur in any region between the tip and the calyx.

Unlike Aspergillus niger, Alternaria sp. is capable of penetrating cuticle and fully differentiated epiderm. Paraffin sections of unwounded fruits which had been artificially inoculated by spraying the spores on the surface, showed numerous hyphal penetrations of the cuticle and underlying epiderm. One such penetration is illustrated in figure 7. This agrees essentially with the observations of Young (13), who illustrated

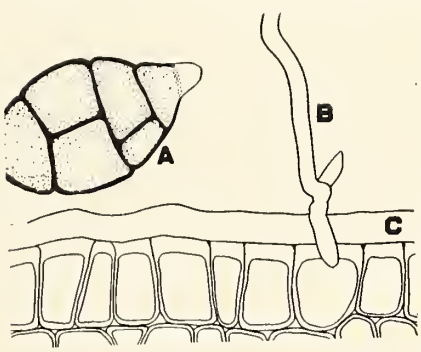

Fig. 7.—Section through the rind of a Deglet Noor date fruit, showing the direct penetration of cuticle and epiderm by Alternaria sp. following artificial inoculation: A, spore; B, fungus hypha; C, cuticle.

the penetration of the epidermis of potato leaves by Alternaria solani.

The close association between the ripening process in the fruit and the susceptibility of the tissues to infection by Alternaria directed our attention to the chemical gradients in the rutab stage. Fruits in this stage were sectioned transversely into three portions: (1) the turgid, unripened portion at the calyx end; (2) the transition zone; and (3) the more mature portion at the tip end. Analyses made on these samples are reported in table 2. The analytical

TABLE 2

The chemical gradient of some substances in the calyx end, transition region, and tip end of Deglet Noor fruit in rutab stage. (Values expressed as percentage of pulp, fresh weight basis.)

Substance	Calyx end	Transition region	Tip end
Moisture	49.70	37.92	31.64
Solids	50.30	62.08	68.36
Tannins (Cinchonine precipitate)	0.98	0.74	slight positive test
Stiasny compounds	1.77	1.84	0.87

values show the existence of a chemical gradient in the fruit of the rutab stage.

Since the epiderm is the first tissue which the fungus reaches after penetrating the cuticle, it seemed that these outer layers might be particularly important in the relative resistance of the fruit to fungal attack. Cold-water extracts of scrapings of the fruit surface in the kimri, khalal, and rutab stages were tested with ferric chloride for tannin-like substances. All samples gave good positive tests except the one from the translucent portion of fruit in the rutab stage. This gave but a slight reaction. Paraffin sections from the samples, when examined microscopically, indicated that these scrapings consisted only of the epiderm and one or two layers of hypoderm. Although the exact reason for the change in the relative susceptibility to Alternaria is unknown, it is of interest to note that at this stage of maturity there is a change in the concentration of tannin-like substances.

The growth of Alternaria sp. was observed on Czapek's media (without ferric chloride), to which different amounts of digallic acid, a true tannin, had been added. As indicated in table 3, good mycelial growth was obtained at 0.0, 0.08, and 0.31 per cent digallic acid; development at 1.25 per cent was markedly inhibited; while at 5.0- and 20.0-per cent concentrations no mycelial

TABLE 3

The relative toxicity of various concentrations of digallic acid in Czapek's media (minus ferric chloride) to Alternaria sp.

Concentration of digallic acid, per cent by wt.	Spore germination	Mycelial growth	Spore formation
0.00	yes	luxuriant	yes
0.08	yes	moderate	yes
0.31	yes	moderate	yes
1.25	yes	poor	yes
5.00	trace	none	none
20.00	none	none	none

growth was observed. Since growth of Alternaria sp. is inhibited by true tannins, it seems that this fungus might also be inhibited by tannin-like substances.

Determinations for the true tannins and the tannin-like substances were made on the scrapings from the surface layers by modification of the methods outlined by Duthie (4). It can be seen from table 4 that

TABLE 4

A comparison of the tannin and tannin-like substances in the epidermis and outer hypodermal layers of Deglet Noor dates in the kimri and khalal stages, respectively. (Values expressed as per cent of fresh weight.)

Stage of maturity	Sample number	Tannins (Cinchonine sulfate precipitate)	Tannins and tannin-like substances (Stiasny compounds)
Late kimri	1	slight positive test	2.74
Late kimri	2	slight positive test	2.88
Khalal	1	slight positive test	4.45
Khalal	2	slight positive test	4.26

whereas the percentage of Stiasny compounds (tannin-like substances) were relatively high in the kimri and khalal stages, only slight positive tests of the true tannins (cinchonine precipitate) were obtained. It was not determined whether these positive tests represented concentrations of true tannins which would be toxic to Alternaria sp.

While it is clear from the work of Walker and Link (12) and from that of Greathouse and Rigler (6) that the type of tannin-like substance (phenol) governs the specific toxicity of the compound to various species of fungi, we cannot state what compounds are present in the date epiderm and hypoderm which might inhibit the attack of Alternaria. However, we have identified flavones in these outer layers in both kimri and khalal fruits and find, in agreement with the literature, that we can change these chemically into solutions of pink colors. Flavones are supposed by some to be the precursors of the anthocyan pigments of which the red-date pigment is a member. Indirect evidence from various sources suggests that these contain phloroglucin or similar phenols. Further work along these lines is being continued.

It might be stated that since fruit in the tamar stage is not susceptible to fungal attack, the foregoing discussion is perhaps out of line with general observation. However, it can be seen that the percentage of moisture (table 2) increases from the tip to the calyx end. This means that the percentage of solids is greater in the tip than in the calyx end of the fruit. As the total sugars increase during the development of the date, there is a corresponding increase in the osmotic pressure of the sap, figure 8. In the tamar stage, it is thought that the relatively high osmotic pressure is largely responsible for resistance to decay. As the pulp of the date in the tamar stage must contain an abundance of sugar crystals, the sap exists, in all probability, as a saturated sugar solution. The maximum osmotic pressure which has been measured (rutab stage), amounted to 86 atmospheres or approximately 1200 pounds per square inch. It is difficult for fungi to develop in solutions of high osmotic pressure.

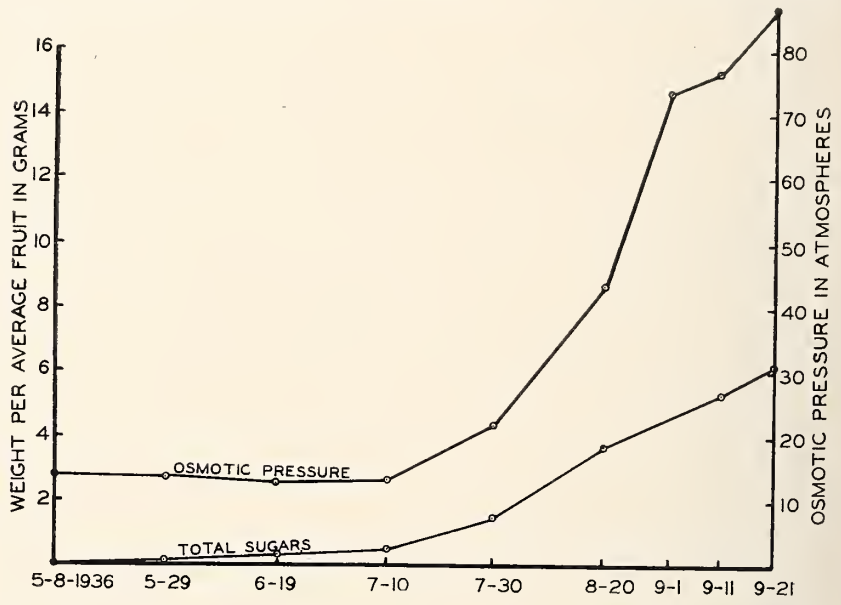

Fig. 8.—Curves showing the corresponding increase in osmotic pressure and total sugars during the development of the Deglet Noor date fruit.

SUMMARY

Fruit spoilage due to microorganisms constitutes the most important group of date diseases in California. At least 20 species of fungi and several forms of yeasts and bacteria have been cultured from naturally infected dates of the Deglet Noor variety. All these fungi will enter ruptures in the rind of the fruit which are associated with water injury. Under favorable conditions certain of these fungi are also capable of penetrating unwounded fruit surfaces. This discussion is confined to calyx-end rot caused by Aspergillus niger and side spot decay caused by Alternaria sp.

Susceptibility of the date to fungus spoilage falls mostly within the khalal and rutab stages of maturity. Except in the tamar stage, the moisture and sugar concentrations appear to be favorable for fungus growth. Some of the factors which govern resistance of the fruit to fungus attack have been studied and it appears that the fruit has both structural and chemical types of protective mechanisms.

In the absence of wounds, Aspergillus niger, the common black mold, gains entrance to the fruit in the region beneath the calyx, but apparently cannot penetrate the surface elsewhere. This region beneath the calyx is thought to be vulnerable to attack because the newly forming tissues are not protected at first by a cuticle and a thick outer epidermal wall. While resistance in this case appears to be mechanical in nature, there are other factors involving the enzymatic action of the fungus which may add complexity to this phase of the problem. The true tannins, localized in a deep-lying tissue of giant cells, are not important in protecting dates from A. niger.

Germ tubes of Alternaria sp. initi-

ate side spot decay by the direct penetration of fruit in the rutab stage. The lesions when first visible are situated in the turgid, unripened portion of the fruit within a short distance from the advancing margin of the translucent tissue. At this stage of maturity there is a decrease in the concentration of tannin-like substances in the epiderm and hypoderm, which is correlated with the loss of resistance to Alternaria sp. Although these tannin-like substances have not been identified, they are thought to contain phloroglucin or similar phenols. Since Alternaria sp. is capable of penetrating the cuticle and thick epidermal wall of the date, the protective mechanism here involved is chemical in nature.

Resistance of dates in the tamar stage to the attack of fungi in general, is thought to be due to the very high concentrations of sugar present in the fully cured fruit.

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AERATION AS A FACTOR IN REDUCING FRUIT SPOILAGE IN DATES

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INTRODUCTION

IN 1938 Bliss (1) read a paper before the Fifteenth Annual Date Growers' Institute entitled "Spoilage of dates as related to management of the fruit bunch." It was indicated that spoilage of dates may result from several types of physiological disturbances (water injury, blacknose, etc.) and from pathogenic diseases caused by a number of different kinds of living organisms.

Results of field experiments at the garden of B. S. Boyer, Indio, were given for the years 1935, 1936, and 1937. It was shown that in the wetter years of 1935 and 1936 the percentage of fruit which was spoiled by fungus decay was reduced considerably by aerating the bunches. This was accomplished by means of (1) fruit strand separation with wire rings, (2) by bags which allowed increased ventilation of the fruit, and (3) by the removal of fruit strands from the center of the bunch. In the very dry year of 1937 there was little fungus spoilage and during that period no advantage was obtained from aerating the fruit.

The present paper contains the results of similar field experiments for the years 1938 and 1939 and, in addition, describes the manufacture of wire rings by a new and less costly process than that previously employed.

FRUIT SPOILAGE EXPERIMENTS

Field experiments were designed to test the effect on fruit spoilage of perforated paper tubes (bags), methods of installing these tubes, and wire rings. These trials were conducted on certain 12- to 13-year-old Deglet Noor palms in a five-acre block belonging to B. S. Boyer. The height of the ripened fruit was such as to require the use of 14-foot ladder for harvesting.

Thinning of the fruit was begun at the time of pollination when all of the fruit strands were shortened. The number of fruits was further reduced in May when the central strands of each bunch were removed entirely. Thinning was completed by reducing all of the experimental bunches to approximately the same size. Eight hundred fruits per bunch were retained in 1938 and about 1100 in 1939. The time of different operations in the management of the fruit bunches is shown in Table 1. A comparison of the dates given for the period of fruit harvest, indicates that the crop of 1939 was about two weeks more advanced in its development than that of 1938.

Wire rings similar to those described by Bliss (1) were inserted in certain bunches when the fruit was in the late kimri (green) stage of maturity and at a time prior to or coinciding with the first appearance of water injury. These rings spread the fruit strands apart so as to produce a circular opening of about eight inches' diameter in the center of the fruit bunch.

Heavy crepe paper tubes (bags) were used to cover all of the experi-

TABLE 1

Time of different operations in the management of the fruits bunches

Operation	1938	1939
Thinning completed	July 20 *	May 17
Rings inserted	July 20	July 24
Bags installed	August 29	August 14
Baskets hung	August 29	August 30
Fruit harvested	September 23 to November 16	September 13 to November 2

*These bunches had been thinned heavily at time of pollination.

mental bunches. In 1938 the tubes were 35x36 inch O-D "Arksafe" unwaxed, 33⅓ per cent stretch, with a hem on the inside at the bottom. The paper in some of the tubes was continuous or unbroken (regular) while that of other tubes was perforated with irregularly-shaped holes one-eighth inch or less in diameter. Instead of being clean-cut, circular holes, they were small tears in the paper such as might be made by inserting the point of an ice pick from the outside. The perforations were in six rows, starting 15 inches from the upper edge of the tube and spaced two inches apart. The holes were three-eighths of an inch apart in the row and all together there were about 1,150 of them per tube. In 1939 the tubes were "Arksafe" 36x36 inch, OO-D (55 lb. basis) unwaxed, full 33⅓ per cent stretch and with a hem on the inside at the bottom. A part of the tubes were perforated from top to bottom with many rows of tiny holes about the size of a pin prick and spaced one-half inch apart each way, staggered.

Wire baskets, 30 inches square, were suspended from overhanging leaves for the purpose of catching all fruits that dropped from the bunches during the later stages of ripening.

At intervals of 9 to 16 days the tree-ripened dates and immature fruits showing fungus spoilage were picked and taken to the laboratory where they were weighed. Each fruit was examined individually and classified according to the general type of spoilage shown. Fruits with checks and tears (ruptures) due to water injury were grouped together. Checked fruits in which the tip ends were perceptibly darkened were classified under the heading of "blacknose." Those fruits showing evidence of fungus or bacterial attack were said to be "rotted." The lots of fruit were rated on appearance, quality, and freedom from blemish as suggested by Haas and Bliss (2). Judgment regarding the symptoms of fruit rot was based on the experience gained from culturing microorganisms from many fruits.

The records of precipitation at the U. S. Experiment Date Garden, Indio, California, are given in Table 2 for the periods from July 1 to December 31 in the years 1938 and 1939. These meteorological data were taken within 200 yards of the experimental palms. The fruit ripening season in 1938 was practically free from rainfall while that in 1939, especially September, was one of the wettest that has been recorded. Because of this marked difference in atmospheric moisture conditions, the loss from fruit spoilage in 1939 was at least 10 times greater than that in 1938.

TABLE 2

Rainfall recorded at the U. S. Experiment Date Garden, Indio, California, during the months of July to December, inclusive, in the years 1938 and 1939*.

	1938		1939	
Month	Day	Rainfall, inches	Day	Rainfall, inches
July	18	.02	--	none
	22	.05		--
August	--	none	2	trace
		--	22	trace
		--	23	trace
September	18	trace	4	.15
	27	trace	5	1.15
		--	6	.65
		--	7	.08
		--	9	.03
		--	11	.03
		--	12	.09
		--	24	6.45
		--	25	.33
October	--	none	--	none
November	--	none	9	.29
		--	28	.27
December	15	.35	23	.13
	16	.68		--
	18	.04		--
	19	.64		--
	20	.53		--
	21	.04		--
	22	.03		--
	Totals	2.38		9.65

*Data supplied through the courtesy of Dewey C. Moore, Scientific Aide (date investigations), U. S. Dept. of Agriculture.

The first evidence of checking in 1938 was observed July 20 when the fruit was entirely green but of nearly full size (late kimri stage). On August 29 the fruit was mostly in the red or khalal stage. By this time there was a mild form of checking on a considerable number of fruits but practically no tearing. Blacknose was in evidence at the center of certain poorly aerated bunches but the degree of injury was slight. During the ripening season very few side spots were observed. Fungus spoilage was due mostly to calyx-end rots. Numerous instances were observed in which the calyx remained attached to the fruit when harvested. In cases of this kind a green Penicillium was found commonly about the connective tissues just beneath the calyx lobes.

In 1939 there were prospects for a large crop of Deglet Noor dates in the Coachella Valley. Ripening had begun near Indio by August 30. A good deal of checking and a moderate amount of blacknose were evident in the bunches of experimental fruit at this time. Although in August there had been only traces of rainfall, there had been periods of high relative humidity and intense heat. Two heavy rain storms occurred in September. The first extended from the fourth to the twelfth day, inclusive, and although the total rainfall during this period was only 2.18 inches, the damage to the fruit was thought to be greater than that from the second storm (September 24 and 25). During the nine-day period of the first storm, rain fell on seven days and the entire period was characterized by high relative humidity and air temperatures* which are favorable to rapid growth of the fruit spoilage fungi. The second storm was very severe but of relatively short duration. It was followed by fairly good drying weather including some wind.

*Unpublished data on file at the Citrus Experiment Station.

The experimental fruit bunches were examined during the rain storm on September 6. The unwaxed paper date covers (bags) were saturated with water, and moisture was dripping from date fruits which touched the paper. Similar fruit bunches, not included in the experiment, had been covered with paper tubes containing 7½ per cent paraffin. The dates in these bunches appeared to be dry except for some leakage of moisture along the fruit stalk and cases in which small droplets of condensed moisture hung to the fruit surfaces. During the storm the bunches containing wire rings to

separate the fruit strands appeared just as wet as those without rings.

On September 13 the condition of the experimental fruit was bad. In all of the bunches the outer fruits which had touched the bags during the storm were badly torn and moldy. Perhaps more tearing was present in the bunches with wire rings than in those without rings for the reason that in the former group a larger number of fruits had been held against the wet paper. However, there was noticeably less spoilage at the center of aerated (ringed) bunches than in those where the strands of fruit were pressing together in a sticky, moist cluster.

The experiments for 1938 and 1939 are summarized in Table 3. The

TABLE 3

Effect of bunch management on weight, spoilage, and rating of Deglet Noor dates

Group No.	Bunch treatment: Number of fruit bunches	Average number fruits	Type bag	Strand separation	Weight per fruit, grams	Fruit spoilage per cent: Water injury	Blacknose	Rot	Rating: 10 = perfect
				1938					
1	4	757	Reg.	None	11.33	70	5.5	4.2	5.9
2	4	768	Reg.*	Ring	10.83	60	2.5	4.0	6.9
3	4	737	Per.	None	11.14	69	2.9	3.3	6.5
4	4	749	Per.*	Ring	11.03	63	1.2	2.2	7.0
5	4	773	Per.	Ring	11.07	64	1.1	2.2	6.9
				1939					
6	5	1024	Reg.	None	10.76	83	4.6	43.8	4.9
7	5	976	Reg.	Ring	10.50	81	1.7	38.8	5.4
8	5	1044	Per.	None	10.57	91	7.2	63.4	3.3
9	5	1008	Per.	Ring	9.63	82	2.5	37.8	5.2

*A portion of upper edge of paper tube left hanging free at one side of the fruitstalk.

40 fruit bunches are placed in nine groups according to the year and the kind of management received. There are three kinds of bunch treatment shown: (1) extent of thinning, (2) type of bag, and (3) fruit stand separation. In the crop of 1938 bunches of moderate size had been thinned uniformly to about 800 fruits each so that an average of about 750 fruits per bunch were harvested. In 1939 larger bunches had been thinned uniformly to about 1100 fruits each and at harvest time each bunch yielded about 1000 fruits. Regular (unperforated) and perforated bags were tied in the usual manner (entire upper edge of the tube gathered tightly about the fruit stalk) except in groups No. 2 and 4 where a portion of the upper edge of the paper tube was left hanging free at one side of the fruit stalk. Fruit strand separation was accomplished in both seasons by the insertion of star-shaped wire rings 12 inches in diameter.

It will be seen that the average weight per fruit was somewhat greater in 1938 than in 1939. This result is apparently related to the extent to which the fruit bunches were thinned. It should be noted also that in 1939 because of severe spoilage, many immature fruits were picked from the bunches. This tended to increase the average weight of the fruits.

The percentages of fruit spoilage due to water injury and rot were much greater in 1939 than in 1938. The values for water injury in 1938 refer mostly to a rather mild type of checking while those in 1939 refer to severe tearing in addition to considerable checking. Although the largest variation in percentage of water injury was 10 per cent, it may be seen that in both years, bunches with wire rings had the least water injury while unaerated bunches had the most. Blacknose varied in 1938 from 1.1 per cent in aerated bunches to 5.5 per cent in unaerated ones. In 1939 bunches with wire rings averaged from 1.7 to 2.5 per cent of fruit with blacknose while bunches without rings averaged 4.6 to 7.2 per cent. The small amount of fungus decay in 1938 was limited almost entirely to calyx-end rot due to Aspergillus and Penicillium. In 1939 side spot decay caused by Alternaria was very common and probably as destructive as calyx-end rot. All groups of experimental fruit bunches were severely injured. Groups No. 7 and 9 which were aerated with wire rings, contained 38.8 and 37.8 per cent rotten fruits, respectively, while groups No. 6 and 8 without rings, had 43.8 and 63.4 per cent rot, respectively. It is thought that the perforated bags used in groups No. 8 and 9 provided less protection against rain than the regular, unperforated bags used in groups No. 6 and 7. The very high percentage of rot in group No. 8 may be partially due to this factor.

As might be expected the ratings placed on the lots of experimental fruit in 1938 were higher than those in 1939. Based on a scale in which 10 denotes perfect, groups No. 2, 4, and 5, aerated with rings, were rated 6.9 to 7.0. Groups No. 1 and 3, without rings, were rated 5.9 and 6.5, respectively. Again in 1939 bunches with rings yielded better grades of fruit than did those without. Groups No. 7 and 9, with rings, rated 5.4 and 5.2, respectively, while groups No. 6 and 8, without rings, were scored 4.9 and 3.3, respectively.

DISCUSSION

The results reported in this paper are in general agreement with those reported by Bliss (1) in 1938. Additional weight is given to the opinion that the aeration of Deglet Noor dates is beneficial, especially during years with rainfall and high relative humidity during the period of maturation.

But the methods of controlling fruit spoilage are as yet unsatisfactory. In 1938 it was decided to discontinue further use of the "flap-fold" method in attaching the paper tubes (bags) to the fruit stalk. Tubes with flap-folds are difficult to install and they are often torn by the wind. It was also observed in 1938 that the rows of perforations in the tubes were lines of weakness. The experimental bags used in 1939 were too short to fully protect the fruits on the lower ends of the strands. They were penetrated by moisture and probably they served to retain this moisture about the fruit for some time. The very small perforations in the tubes appeared to be closed during the rainstorm but afterwards they were open again. Since bunches with perforated bags seemed wetter than others with regular bags, it is questionable whether the perforations are desirable.

As previously mentioned, more spoilage of dates resulted from the rainstorm of September 4 to 12, 1939, than from the one 12 days later although the total precipitation in the former was only one-third of that of the latter. This difference was probably due to the longer duration of the first storm during which period the spores of the fruit spoilage fungi had time to germinate and attack the fruit. The reason for aerating fruit bunches bears upon this principle. Although the wire ring does not prevent the deposition of moisture on the fruit surfaces during periods of rain and high relative humidity, it increases the rate of evaporation of

water from the fruit after the rain. Haas and Bliss (2) found that dates transpire large amounts of water, especially at high temperatures. Nixon (3) observed drops of moisture in the interior of fruit bunches early in the morning following a very humid day. It seems likely that this moisture was condensed from the air when the temperature reached the dewpoint (the temperature at which free moisture or dew forms). It is not known exactly how long a period is required for the germination and attack of the spores of fruit spoilage fungi but it is known that they require the presence of free moisture. If by aerating the fruit bunches, the length of time favorable to fungus development is shortened, then there is less chance of infection.

MANUFACTURE OF WIRE RINGS

Aeration of dates by means of a metal ring inserted in the fruit bunch was described in 1931 by Swingle (4). Since that time wire rings have been used by a few growers in the Coachella Valley but the practice has not been adopted generally. The cost of such rings has been relatively high and when installed they have been of some inconvenience during the harvest. Also, the amount of experimental data on fruit aeration has been meager.

The writers have been impressed by the beneficial effects of aeration on Deglet Noor dates over a period of five years. Their attention has been directed lately to methods of manufacturing wire rings which are capable of reducing the cost significantly. Whereas handmade rings, such as those described in 1938 by Bliss (1), cost 8.87 cents each, it is now possible to manufacture a similar product for four cents or less.

A machine (Fig. 1) was designed and built for the purpose of crimping wire. Two gears* from a 1¼-inch, No. 3 rotary gear pump (manufactured by the Gould Co., Senaca Falls, N. Y.) were made to mesh loosely while being turned by a hand-driven crank. Galvanized iron wire, No. 10 Washburn and Moen gauge, was then fed through the gears from below. During an experimental run, two men crimped 1700 feet of this wire in one hour. The crimps in the wire were approximately one inch in depth. In order to make a ring with inside diameter of 12 inches, it was found necessary to use 4.7 feet of straight wire; a ring 9.5 inches inside diameter, required 2.75 feet of straight wire. After cutting the crimped wire in the proper lengths, the ends of the pieces were brought together and spot welded electrically. One of these rings is illustrated in figure 2. The average cost of two sizes of wire rings as produced in an experimental lot of 400 rings is shown in table 4. Charges for materials and labor are as follows: No. 10 W. and M. gauge galvanized wire at $4.60 per 100 pounds (2057 feet); hand labor at $.50 per hour; and welding (labor and machinery) at $2.00 per hour. The cost of different items is thought to be satisfactory except that for cutting the wire. Long pieces of crimped wire lying together on the floor became entangled and thus increased the labor charge.

*Furnished through the courtesy of the Glendora Cooperative Fumigating Company, Glendora, California.

Fig. 2.—Wire ring for aerating date fruit bunches. Taken from a 9½-inch ring made from wire which was crimped in the machine illustrated in Figure 1.

TABLE 4

The average cost of two sizes of wire rings as produced in an experimental lot of 400 rings

Item	12-inch ring Cents	9.5-inch ring Cents
No. 10 W. and M. gauge galvanized iron wire	1.10	0.60
Crimping	0.28	0.17
Cutting	1.10	1.10
Welding	1.50	1.50
Total	3.98	3.37

With experience in handling the wire, this cost might be reduced to less than 0.5 cent per ring.

In examining the 400 rings from the experimental lot, it was noticed that slight cracks in the wire had developed at one side of the welded joint in about five per cent of the cases. These cracks proved to be points of weakness at which places the rings could be broken easily. Most of the rings, however, were very strong. Further criticism of certain rings could also be made because the cut ends of the wire protruded sufficiently to scratch the fruit strands. These roughnesses were removed with a file.

* * *

DISCUSSION

There have been no experiments conducted to compare the relative merits of plain rings with those made from crimped wire. A saving of 0.3 cent each could be made in the cost of plain rings, 12 inches in diameter, because only 3.2 feet of wire would be required. However, it is thought that crimped rings are preferable to circular ones because of their tendency to retain a more even distribution of the fruit strands

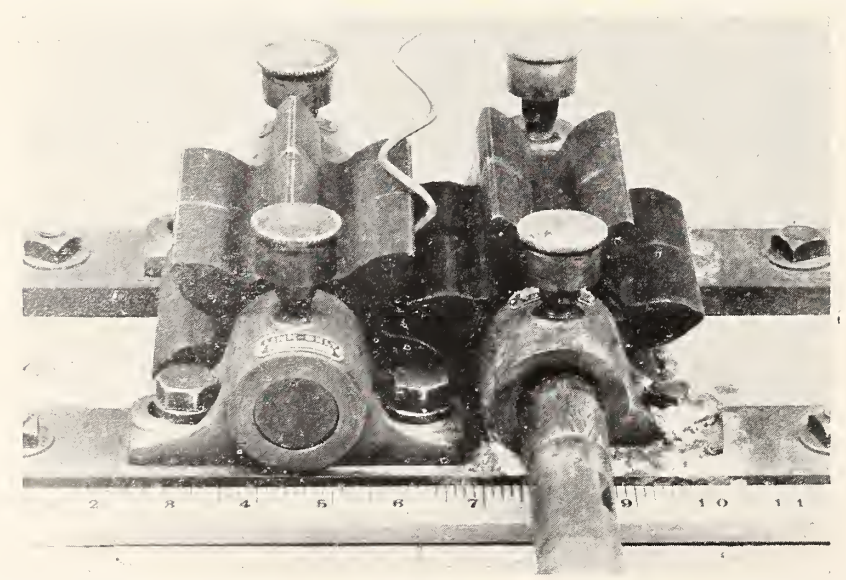

Fig. 1.—Machine for crimping wire. Straight wire coming from below is crimped by passing between two loosely meshed gears. Only part of the crank shaft is shown.

and to stay in place within the fruit bunch for a longer time during the fruit harvest.

Experimental wire rings have been in use for five years and after this length of time, they seem to be nearly as good as new. The most common trouble is the loss of rings because of careless handling. With reasonable care a ring should be serviceable over a period of five years or more. Such usage would make the initial cost seem small, especially if by using rings the value of the crop could be increased on the average by five per cent. While it is too early to evaluate the benefits of aeration to the fruit, it is hoped that the date growers will at least consider the possibilities involved.

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RAIN DAMAGE TO DATES - DISCUSSION

Led by W. G. Jenkins

W. G. Jenkins: I have endeavored, in selecting the growers to present papers under this topic, to cover the different sections of the Coachella Valley from a geographical standpoint. Also, we attempted to discuss the effects of the September rainstorms on the different varieties and from the perspective of the packing house operator. We are hopeful that some of the experiences of the growers taking part in the discussion will be of benefit to the industry when, in the future, we will have to face partial destruction of our dates by rain again. At any rate, these observations will be in the permanent record of the Date Institute, not as a guide to be followed, but simply as the experiences and opinions of the growers while the situation is still fresh in our minds.

RAIN AND ITS EFFECT ON THE 1939 DATE CROP

By J. E. McFarlan

We were fortunate in having all our bags on before the first rain in September; but the wind accompanying the downpour of the 24th and 25th, tore the wet paper from many bunches on one block. So we had an opportunity to study the effect of the storm on both protected and unprotected dates. The bunches from which the bags were torn were almost a total loss.

In the balance of the garden the fruit injury appeared to be caused more from the humidity following the rains than from actual water damage; the center of heavy bunches soured due to lack of sufficient aeration. Our oldest palms are eleven years and are interplanted with grapefruit of the same age. There was more split fruit in this block than elsewhere. The bunches receive less sun and the moisture took longer to disappear.

Immediately following the first rain we picked and threw on the ground all the badly torn fruits; the dates which were in the late khalal stage split worse than those almost ripe. This chore made our picking cost high, but would have simplified the subsequent pickings if it had not rained later in the month. After the cloudburst, the men merely shook the bunches gently before each picking, in an attempt to eliminate part of the worthless fruit. Most of that which dropped was loose at the calyx. This type of injury seemed to me to be the most difficult to detect in picking, as many dates which appeared to be good, were found to be wormy when pressed slightly, although there was no obvious break in the skin.

If one attempted to pick at the usual rate of speed, he usually failed to observe the small dark decayed spots, a sign that the fungi had started to work in the places where the moisture had collected. This made the percentage of culls exceedingly high at the packing houses.

In summary, the bunches unprotected by bags suffered almost complete spoilage.

The properly bagged fruit was ruptured more from continuous high humidity than from the actual rain.

The centers of large bunches soured, due to lack of aeration.

Fruit in the late khalal stage appeared to be more susceptible to water injury.

OBSERVATIONS ON RAIN DAMAGE TO DATES

(In the Indian Well District)

By H. L. Cavanagh

At the time of the first damaging rain on September 4, 1939, about 75 per cent of our date bunches were covered. It is not uncommon for us to have as much as 50 per cent uncovered at this time of year, as it is usually the last of September before all of our bags are on. Those bunches that were not covered were distributed between palms just coming into good bearing, full bearing palms of from 8 to 16 years and some of the oldest and tallest palms in this section. The damage from the rain appeared to be fairly uniform in all ages of palms in both the covered and uncovered as individual groups. Unfortunately, none of the bunches on the oldest palms were covered, at the time of the rain, so we were unable to make comparisons between the damage to covered bunches on the oldest palms and covered bunches on the intermediate group.

One 5-acre block, where we have had some difficulty in securing a deep penetration of irrigating water, had the smallest loss from the rain. The loss in this particular block was about 40 per cent and the greatest loss was a 5-acre block that was uncovered at the time of the rain and had better than a 90 per cent loss.

About 20 palms of a 9-year-old block were uncovered at the time of the rain. At that time it appeared that the loss here was no greater than the balance of the block, which was covered. As the season progressed, however, this proved to be not the case — as the damage continued here until practically the entire amount of fruit was lost.

In the case of bunches covered following the first rains, and after the bunches were fairly well dried out, the damage to the fruit continued and it appeared that no good was accomplished by covering after the first rains.

It appears that in this area the greatest damage to the crop was not the immediate effect of the rains, but the weather that followed and

the spot-rot that developed. This spot rot continued throughout the season and until we finished picking in mid February.

The dates least damaged by the rains on our property were those pollinated from April 7 to 14. These bunches were the last to be pollinated and apparently the fruit was not far enough advanced at the time of the rain to be damaged as badly as the fruit on the earlier bunches.

EFFECTS OF SULPHURING AFTER RAIN

By H. R. Whittlesey

At the time of the heavy rain in September of 1939, the dates on the Krutz ranch had just started to ripen, many were still in the "red" stage, consequently, there were many split. The weather continued damp and cloudy and within twenty-four hours mould was visible in most of the bunches.

One man was started on the dusting machine in the center of the garden, giving each bunch a heavy application of sulphur under each bag. It took this man four days to get around to the starting point and in that time mould was in every unsulphured bunch and on almost every date. Most of the dates became sticky even though they were still green. There was no mould visible on the dusted dates. In the case of those bunches which became too mouldy before they were dusted, there was a shattering or drop of approximately 75 per cent.

The best dates of the season were picked from those bunches sulphured immediately after the rain and harvested in late December.

Although the sulphuring saved many dates, this gain was partly offset by difficulties in the packing house, caused by sulphur adhering to the dates. Sticky dates covered with sulphur clogged machines and cleaning equipment. Mrs. Edna Cast, who packed the crop, also had the problem of removing the sulphur from the cracks in the dates, where it was very noticeable. However, she was able to save a large percentage of the crop delivered to her.

Sulphuring, even on wet bunches, does not seem to have any effect on the skin of the date. However, when this same method was tried in 1928 it did not seem to prevent the development of mouldy spots which caused so much loss that year. The sulphur does seem to dry out the bunches more rapidly.

OBSERVATIONS OF THE EFFECT OF RAIN ON KHADRAWI DATES

By Leland J. Yost

My observations of the effect of rain on Khadrawi dates were limited to my own plantings and may not coincide with those of growers in other districts of the Coachella Valley.

I have made no attempt to protect this variety from rain and use only a cheese cloth cover to prevent damage by birds.

My harvesting procedure for a number of years has been to pick in one-pound baskets, placed twenty to a tray. The tray has an 11/16" cleat above the top of the baskets to allow a free circulation of air while the dates are in storage. After fumigation, the trays have been placed in cold storage in the plant of the Imperial Ice and Cold Storage Co., at Coachella, for a period of from four to eight weeks. During this period of storage, dehydration takes place sufficiently to make the dates of a proper consistency for packing. In fact eight weeks of this ventilated storage has, in the past, dried some dates too much and caused excessive wrinkling and loosening of skins. This method of curing was, I believe, first used on Khadrawis by Mr. T. J. Gridley, many years ago, and I adopted it on his suggestion and have, in the past, found it to be satisfactory.

This season the same method of picking and the same container was used. After the rains the fruit was excessively soft, and difficulty was experienced in picking, as there was a decided tendency for seeds to pull out and for fruit to mash badly on being placed in the baskets. For several days after each rain the interior of the bunches were wet although the covers were removed and the bunches spread. Frankly, I anticipated a terrific loss.

After four weeks storage, little dehydration was apparent; the dates were too soft and wet to pack, and centers of many baskets were wet, with occasional fermentation. At this time a quantity of fruit was taken from the baskets and placed on wire bottomed trays, thinly spread.

After six weeks storage the fruit in baskets showed some dehydration, but not enough for packing, while that in wire bottomed trays had cured to the desired consistency. More fruit was then placed in trays; in fact, all would have been transferred, if trays had been available.

After eight weeks, all fruit was graded. The tops of the baskets were in proper condition, but the fruit in the centers was still too soft and wet. It was, therefore, spread on trays and stored in the packing room near the heating unit. In an average time of about seven days, this fruit had dehydrated sufficiently, but some required up to two weeks. A fan was used on the wettest stacks and drying was speeded up.

There seems to be very little tendency for fully matured Khadrawis to ferment after a period of cold storage, even if they still contain an excessive amount of moisture, and are exposed to a reasonably high temperature for a considerable period, leading one to believe that a room with controlled ventilation and temperature could be used to advantage in rainy seasons.

There was practically no fermenting on the tree, although there was some slight loss from rain checks on very immature fruit. This was negligible, although the loss may have been greater in groves that were not as far advanced as mine.

As an experiment, paper covers were used on one tree and although the covers were raised on the day following each rain, the fruit was almost a total loss, on account of fermentation.

My total loss from all types of damage did not exceed 10 per cent.

Conclusions

I am of the opinion that practically all loss could have been avoided if the baskets had been only half filled on picking and the dates then spread thin on wire bottomed trays for storage in a plant with a proper circulation of air and a temperature of about 28 degrees.

Under the same conditions again, I would endeavor to obtain use of a room with forced ventilation at a temperature of about 70 degrees, as dehydration, after cold storage, can be speeded up in this way.

It appears that a light cheese cloth is the only advisable protection for bunches, as anything which impedes a free circulation of air through the bunch will cause fermentation.

This season has verified, in my mind, the position of the Khadrawi as one of our most rain resistant varieties.

1940 Date Crop

The total date crop in California for 1940 was 11,500,000 pounds. The importation of dates from July 1, 1939, to June 30, 1940, was 45,093,450 pounds.

GRADE AND TONNAGE LOSS IN THE 1939 DATE CROP CAUSED BY SEPTEMBER RAINS

By Hugh W. Proctor

For several years prior to the 1939 season marketing conditions for California dates had been gradually but steadily improving, as shown in Table I, below:

TABLE I.

Crop Year	Bearing Acreage	Production by Tons	Farm Price per Ton	Farm Value
1929	809	870	$222	$193,000
1930	879	1,560	140	218,000
1931	986	1,215	60	73,000
1932	1,080	2,160	40	86,000
1933	1,095	2,450	70	172,000
1934	1,244	3,160	80	253,000
1935	1,431	3,250	80	260,000
1936	1,796	3,970	110	437,000
1937	2,202	3,630	120	436,000
1938	2,513	3,510	126	442,000
1939	2,850	2,500	126*	315,000

*Preliminary estimate subject to considerable revision

Sources of data: Compiled by S. W. Shear, Giannini Foundation of Agricultural Economics, University of California, except for 1939.

Therefore, tthe 1939 season was approached with very high optimism by the growers which was increased by the prospects of the largest crop ever produced. Nearly all date palms had recovered from the effects of the severe freeze of 1937 and it appeared that a crop of 12,000,000 pounds was in prospect.

High quality dates were promised as the marketing order had caused growers to do everything possible to improve the quality of the date produced. The prospects of a large, high quality crop with a healthy market demand created by the quality regulations and diverting of substandard dates under the diversion program bid fair to result in the most profitable season for many years.

Harvesting of dates begins in September. With the crop ripening and harvesting preparations completed under the favorable conditions described above, it began to rain on the 4th of September and continued more or less for a period of ten days. Following this the weather continued humid so that the effect of the rain prevented harvesting for many days and before it was begun, except on a small scale, a veritable cloudburst occurred on the 24th of September, on which date 6.45 inches of rain fell between 5:00 A. M. and 12:00 Noon.

Obviously no effective protection could be secured against such a rain as this. Dates which had entirely ripened before the rain were damaged the least. The dates which were ripening were in many instances split open causing the skin to curl back. Dates which were green, but near the turning stage were apparently uninjured but later when picked were found to contain spots which rendered them unmarketable.

Dates which were entirely green, so as not to be subject to immediate rain damage were, nevertheless, injured by the excessive moisture so that there was a great loss in quality and most of them had to be packed in the lower grades.

In Tables II and III, is shown the production grade pack out of the 1938 crop in comparison with the 1939 crop.

The average annual rainfall for the past 60 years is approximately 3 inches. Records show a rainfall of 8.96 inches for the September, 1939, storm period alone. This rainfall came at a time when the harvesting of the Deglet Noor date crop was just getting under way.

As a result of this rain many new difficulties confronted the grower, the packer, and all concerned. In the field the grower had to determine which dates were worth salvaging. In most cases the damaged fruit was removed from the bunches, and this operation alone added considerably to the picking cost. Due to the long humid period following the rain, covered bunches suffered damage along with uncovered, although not to as great an extent. In many cases the shaking of a bunch would result in the shattering of from 25 per cent to 65 per cent of the dates.

Unquestionably, the packing houses experienced more difficulty with the handling of the 1939 date crop than has been experienced at any time during the life of the date industry in California. This was due, in a large part, to the fact that so many of the dates, especially those picked soon after the rain, were too moist and soft to pack at the time of grading. These had to be dried on trays

TABLE II.

California Date Crop
Production and Average Price Received by Growers
Crops of 1938 and 1939

Grade	Production -- Pounds Packed Weight 1938	Percentage	1939	Percentage
Standard	5,219,400	74.4	3,548,000	68.9
Substandard	1,800,600	25.6	1,604,000	31.1
Total	7,020,000	100.0	5,152,000	100.0

TABLE III

Comparative Study of Grade Percentage and Average Returns to Growers for Crop Years of 1938 and 1939

Standard Grades	Percentage 1938	1939	Average Return to Grower 1938	1939
Fancy	29	3.49	10.5c	14c
Choice	30	30.91	6	8
Standard		15.05		6
No. 1 Dry	14	5.79	4.7	8
Sub-Total	73	55.20	Avg. 7.4c	7.83c
Substandard Grades				
No. 2 Dry	23	24.68	3.4	3
Culls & Shrinkage	4	20.12		
Grand Total	100	100.00	Avg. 6.5c	6.38c

The average return shown in the above table is computed on the actual packed out weight of the merchantable dates both standard and substandard grades and does not include culls and shrinkage. The abnormally high percentage of culls and shrinkage in the 1939 crop was due to the unseasonable September rains. The percentage is computed on received weight at packing house.

RAIN DAMAGE, FROM THE STANDPOINT OF THE PACKING HOUSE

By P. W. VAN Der Meid

In September, 1939, the Coachella Valley experienced the most severe and damaging rainfall on record. for a period of from two days to two weeks, depending upon the facilities of the packing house for drying. In our packing house, we believed that the drying capacity was sufficient to handle a normal amount of moist fruit. However, this space was soon filled to overflowing and it was neces-

sary to stack trays of moist dates here, there, and everywhere, with large fans circulating the air as evenly as possible. The very humid weather condition which prevailed for about two weeks following the rain made the drying of these dates a long and slow process. After the humid condition ceased this drying method was, of course, more satisfactory.

It is safe to say that every packing house was taxed to the utmost as far as trays and drying capacity was concerned, in handling the excessive amount of fruit which had to be dried during this critical period. Judging from past experience with rain damage, no doubt many packers felt sufficiently equipped with drying facilities to handle the usual amount of wet dates in a normal year.

The amount of cull dates in the 1939 crop broke all records. This amount varied from 5 per cent to 45 per cent in different gardens, depending upon location and rain damage. The average was around 25 per cent. The great variation in culls was, no doubt, due to some extent to the care in picking. Then, too, the growers, realizing that the crop loss was considerable, were naturally anxious to salvage all usable dates. Also, many dates which appeared to be of good qualty at picking time developed moldy spots by the time they were ready for grading and had to be culled. Many dates developed mold on the inside which was hard to detect from the outside appearance, even by the most competent and experienced graders.

Therefore, the whole process of grading was slowed down to about one-half of normal in an effort to detect and discard fruit of this kind. This, of course, added greatly to packing costs. Many of the dates had to be graded over several times before the final packing. In our packing house, the cost of grading was $1,000.00 more during the 1939 season than in 1938 on approximately the same tonnage.

Estimated Loss

The amount of dates delivered to the packing house was 52 per cent of the original estimate made before the rain. Deducting the excess of culls above normal leaves a net loss of approximately 61 per cent. Aside from this loss in tonnage there was also a general loss in quality.

In conclusion, I believe that the experience of every packer during this past season has demonstrated, more than anything else, the necessity of having adequate drying facilities for emergency.

DRYING DATES UNDER ADVERSE WEATHER CONDITIONS

By Robert E. Cook

Maturation problems and drying of dates have been neglected of late years, but the season just passed has brought them back into the foreground.

The California Date Growers Association was fortunate last fall in having just built three new combination maturation and drying rooms. The success of these rooms exceeded expectations in spite of the extreme conditions experienced.

Wet weather always creates three problems:

(1) How to accomplish any drying at all;

(2) How to prevent fermentation or souring;

(3) How to check mold growth.

When the need for drying is most acute, fruit will gain moisture from the atmosphere instead of losing it. But if quick drying can be accomplished, all three problems are solved at once. When drying facilities fail to function, a temporary solution is cold storage. But unless the storage time is short and the fruit goes very quickly into retail trade channels after removal, this is a risky alternative. For molds thrive in 32 degree storage if other conditions are right, and deterioration proceeds much faster in wet than in cured fruit except at extremely low temperatures, as shown by Barger (1).

During an extremely wet period such as September, 1939, the problem becomes mostly one of salvage. Any delay in plant operations at such a time may result in thousands of pounds of moldy or sour dates. Wet fruit sometimes seems to grow whiskers overnight; and fruit which in an ordinary year would be expected to have good keeping qualities may develop mold in a few days.

Our experience this year has indicated that with adequate drying facilities, spoilage taking place in the packing house need not be great. However, rain damage always hits top grade fruit hardest, thus lowering the average quality.

The new equipment of the California Date Growers Association consists of three rooms, each with a capacity of 20,000 pounds of fruit on trays. Separate blowers are provided for each room. Air is drawn from outside at times, or else it is partially or totally recirculated. Before entering the room the air is passed over steam heated fins, a thermostat being provided to maintain the desired temperature. The fruit supplies all moisture needed. Humidity is controlled either by regulating the amount of air recirculated, or charging the temperature or both. In cloudy or rainy weather, drying is accomplished by heating the air just enough to drop the relative humidity to around 50 per cent. This was surprisingly easy to do at all times. Never was it necessary to raise the temperature above 95 degrees and usually 86 to 88 degrees was sufficient.

Our new rooms with controlled temperature and humidity are found to have several advantages in drying:

1. Reduction in time required.

(a) Drying is continuous. When outside air is depended on very little drying takes place from 12 midnight to 8 A. M., particularly in cold weather. With our present equipment night time drying is as good or better than day time.

(b) Ripening and drying can be done at the same time. During the latter half of the season this frequently results in a saving of three or four days on each lot of fruit.

2. The amount of darkening and formation of syrup is reduced due to the immediate removal of all excess moisture liberated within the fruit as ripening progresses. This results in superior appearance, flavor and keeping qualities.

3. Mold growth is held in check, due also to the immediate removal of excess moisture.

4. Drying while it is raining.

The rain of September 24th was not only unseasonable but also unusually warm. The outdoor temperature was 78 degrees at 6:30 A. M. while it was raining. In spite of this, we were able to maintain the air in our drying rooms at 50 per cent relative humidity or below. During later rains in cold weather it was possible to obtain humidities of 20 to 30 per cent at 86 degrees, although 45 per cent was actually used.

In regard to the operation of our equipment this past season or recommendations for the future, we are unable to give more than generalities. As you all know, every year is different when it comes to handling dates, and final conclusions cannot be based on the experience of one season.

Our rooms were in operation for only one week before the rain of September 24th, so we have very little data on drying in hot weather. During October and November temperatures of 85 to 90 degrees were used with good results. The most

desirable point of relative humidity varied during the season with charges in moisture content and degree of ripeness of the fruit when picked. Humidities as high as 65 and as low as 35 per cent were used.

The time required also varied with the season from three or four days early in the season to six or eight days in December.

Proper air distribution is a factor of extreme importance. Air should reach all parts of the room as evenly as possible. The velocity of air movement need not be high as long as there are no dead air pockets. Fruit should not be much over one layer deep on the trays and several inches of space should be allowed between the stacks of trays.

Towards the end of the season as the fruit began coming in greener, difficulty was encountered in arriving at a humidity which would dry the fruit satisfactorily without being too rapid. When six to eight days were required to ripen the fruit a variation of 5 or 10 per cent in humidity throughout this time made considerable difference in results. Too rapid drying causes the skins to become harsh and brittle and also interferes with the ripening processes, leaving the date with a fibrous instead of a smooth texture.

With the idea in mind of finding a more nearly fool-proof method of operation which would not require such close attention, an entirely different procedure was evolved. The method is an adaptation to our drying rooms of one of the earlier methods of drying, and consists of the very simple process of exhausting the warm humid air at intervals while bringing in fresh air from outside. With the large heating capacity available we were able to heat this air to the desired temperature before it entered the room, thus blowing very dry air through without cooling the fruit. After fifteen to thirty minutes of this the intake was closed and all the air recirculated until the humidity again built up to an objectionable amount. This process was repeated as often as seemed desirable, usually keeping to a four or six hour cycle.

It was found that by this method the rate of drying could be controlled much more readily than with constant humidity. It could be made as rapid as desired by shortening the time of recirculation or increasing the time of blowing dry air through the room.

This method appears to be readily applicable to the small packing house and should require little equipment other than fans and a source of heat. In any event it has possibilities worth investigating.

There is one other point worth mentioning at this time. It is often assumed that in a packed box containing both wet and dry dates, the moisture content will even up in storage. While this is bound to be true to a limited extent, analysis shows that even after six months there is still a great difference between the wettest and the dryest dates.

We expect to continue experimenting with different combinations of temperature and humidity at the Association packing house and hope to have more definite data to offer by the close of the 1940-41 season.

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References:

(1) Wm. R. Barger. Experiments with California Dates in Storage. 10th Annual Date Growers Institute. 1933.

AFTERNOON SESSION

Chairman, Robbins Russel, Thermal, California

Ladies and Gentlemen: If I may impose on your time just a few moments, this occasion has seemed to me to justify a few remarks, part historical and part dealing with the future.

When T. J. Gridley, Chairman of our Date Growers Committee which was so largely responsible for starting these annual meetings, wrote in his foreword to the first published proceedings in March, 1924,—

"In the publication of the experiences and personal opinions of pioneer growers and others closely identified with date culture, as set forth in these papers given at the 'First Date Institute' held in America, it is hoped that a beginning has been made toward the recording of date history that may be said to be truly American,"—

none of us could envision how truthfully the 16 published Proceedings, from 1924 through 1939, would fulfill his hope.

This continuous, contemporary record of the beliefs and observations of those connected with this industry, since its birth as a commercial enterprise, affords an informative source book for all who would understand much of our problems and failures, as well as our successes. The list of contributors, which I read next, is alone sufficient to recall much of the pageant which in its small way, the growth of this industry presents to interested observers,—a pageant which, unless so recorded, would be lost as the older generation of date pioneers passes.

I now read the list of those whose contributions make up the first ten of these Proceedings:

H. J. Webber; T. J. Gridley; Roland Reed; A. E. Vinson; A. J. Shamblin; A. E. Bottel; Fenner Stickney; C. E. Cook; Thos. E. Allen; W. R. Faries; Henry Middleton; Chester A. Sparey; Leonhardt Swingle; Walter T. Swingle; Bruce Drummond; E. S. Reeves; L. G. Goar; George Swann; W. L. Paul; S. C. Mason; Robt. W. Hodgson; D. W. Albert; R. H. Postlethwaite; Bryan Haywood; Robt. C. Metzler; Arthur W. Christie; Linton T. Simmons; Byron J. Showers; V. H. W. Dowson; H. W. Postlethwaite; Roy W. Nixon; D. H. Mitchell; William R. Barger; A. F. Sievers; M. T. Fattah; Burdette K. Marvin; Homer Smith; M. M. Winslow; J. J. Thornber; C. L. Cudebec; J. E. Pippin; B. H. Hayes; Roy L. Franklin; Mrs. C. E. Cast; Paul S. Armstrong; B. L. Boyden; Dale Bumstead; L. D. Batchelor; L. J. Klotz; Horace Dunbar; Geo. D. Olds, Jr.; A. R. C. Haas; Frank A. Thackery; H. S. Fawcett; R. H. Hilgeman; Edwin Humason; Bryson Gerard; H. R. Whittlesey; E. P. Clarke; Carl L. Crawford; Donald E. Bliss; Bruce S. Boyer; Robbins Russel.

This list, long as it is, fails to include those numerous others who, growers and laymen alike, aided so materially in creating and perpetuating these Institutes. But it is long enough to indicate how varied has been the interest in these meetings,—especially when it is recognized that no contributor or worker has ever received either fee or expenses for his time and effort.

The list would not be complete without the name of the publisher, V. V. Green, who, from the beginning, has so loyally "played ball"

with the Institute,—often at some cost to himself since financing the publication of the proceedings has at times been a serious problem.

Therefore, on behalf of the Date Institute of America, I take this opportunity to record what I am sure is the heartfelt thanks of the industry to these men and women.

Numerous schemes have been tried for assuring the continuation and development of the Institute. As early as 1927 a formal resolution was adopted calling for measures to "maintain and raise the standard of future programs—publish at cost the proceedings of the meetings in standardized pamphlet form." The Farm Bureau,- the Experiment Station staffs,- the County Agricultural Agent's office,- and various grower groups,- all have worked during past years to achieve these objectives.

It is with definite pleasure, therefore, that I announce the creation of a cooperative, non-profit, Date Growers Institute, whose present officers and trustees are listed in the published Proceedings of the 16th Institute, to carry on this important task. Annual dues are one dollar, with membership open to all. I solicit your utmost support for the Institute, through membership and in all other ways. All officers and trustees serve without remuneration. Arrangements have been made to provide office space and clerical staff without cost, at least for the present. If you,—growers and others,—put your collective "shoulders to the wheel," I foresee a still more satisfactory record when we "take inventory" at the end of the Institute's second decade, in 1943.

One point more and I shall turn the program over to the regular speakers. We in this industry not only have to grow dates,—we also have to sell them. Therefore, we cannot but be interested in our competition for the all-important domestic market. So I present the following data, as released by the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce, giving the **Net Imports** of dates (gross imports less tonnage re-exported) into the U. S. A. for the period July 1, 1939, to April 1, 1940:

from China	87,447	pounds
" Hong Kong	20,802	"
" Iraq	37,960,517	"
" Iran	2,355,844	"
" Saudi Arabia	10,569	"
" United Kingdom	4,212	"
Total	40,439,391	"

with a declared value cif U. S. A.,—not counting import duty paid to this country,—of $1,515,000.00, or approximately 3¾ cents per pound.

Our best information is there is little possibility the present world war will diminish this tonnage. In fact, the war may well serve to augment it unless restrictive measures are taken by our own government. It is my understanding that there is little disposition at Washington to take such steps.

Having called these to your notice, I now take pleasure in introducing the first speaker on this afternoon's program.

Dates and Date Products In Egypt and California

By W. V. Cruess, University of California, Berkeley, California

IT was the writer's good fortune and pleasure to visit Egypt while on a sabbatical trip about a year ago. As one interested in fruits and fruit products he had an opporunity to make more or less casual observations on dates and their use in that country. Because of the fascinating character of the country and its agriculture, Egypt was the highlight of our entire journey, which included eleven other countries.

By way of background the following few general statements may be useful.

The known history of Egypt dates to 3200 B. C., time of Menes, first sovereign of Upper and Lower Egypt and founder of the First Dynasty which lasted until 2100 B. C. In 2780-2720 B. C. the step pyramid was built at Sakkara, and 100 years later the great pyramid of Cheops of Giza was built. In the tombs in and near each have been found wall paintings, hieroglyphics writings, carvings, and many articles that illustrate the agriculture, trade and home life of those ancient times. In the ancient illustrations on tomb walls the date palm and its fruit are found. In the National Museum at Cairo, a great treasure house of well preserved relics of ancient Egyptian civilization, we saw specimens of dates from ancient tombs. The dates were blackened with age but easily recognizable.

Egypt has had many changes in rulers in its 5000 years of recorded history. The ancient Persians at one time in about 525 B. C. overran and ruled Egypt; later Alexander conquered Egypt and established the Ptolemy Dynasty of kings. Cleopatra lost out in the first century A. D. to the Romans who with Byzantium (Constantinople) ruled for several centuries. They restored the agriculture long in decay under other rulers. At one time Christianity prevailed in Egypt; in fact the Coptic Church still exists there. I was told that about ten per cent of the population is Christian, and that the priests still use the ancient Egyptian language in rituals. We dined with two of these families, those of former students at California, and took tea with a third, that of the Minister of Commerce. In about 638 Egypt was taken over by Islam, and to this day is a Mohammedan country. Mosques are numerous, and the population is devout in its adherence to the Moslem faith. Yet the Moslems are very tolerant toward the Christians who are no longer persecuted and who participate in the government. At one time the great Saladin of Crusades fame ruled Egypt. Napoleon conquered Egypt and France ruled for a few years. Under French rule began the scientific study of egyptology from which our present knowledge of Egypt's history has grown.

The present king, King Farouk, is the grandson of Mohamed Ali, founder of the present ruling house. He is a handsome, well educated, and very popular young man.

Since the defeat of Napoleon Great Britain has had a hand in the affairs of Egypt. She has now withdrawn from direct rule, and is at present in the position of protector or ally. Egyptians fill most governmental and educational positions. Arabic is the language of the country, of the schools and of the University. Many of the city dwellers can speak or at least understand English; most of those on the land do not. English is taught as a subject in the schools. English garrisons are still maintained as aids and instructors to the Egyptian army which is being built up as rapidly as possible.

The people are a mixture of many races and nationalities. Greeks play a prominent role in industry and commerce. The land is owned in large part in large acreages by wealthy agriculturists to whom land is

the symbol of wealth and stability. However, much of it is held by small owners of a few acres each. Industry and commerce are largely in the hands of Europeans.

Of the 16,000,000 people 80 per cent or about 13,000,000 are engaged directly in agriculture. Most of these are the peasants or "fellaheen" (fellah is the singular), who live in villages and till the soil. They may own their little farms in many cases; in others they rent two or three acres for each family from the landowner, who holding may be 300 to 1000 acres of amazingly productive soil.

In 1798 the land under cultivation in Egypt was about 3,520,000 acres; in 1938 it was 7,000,000 acres and is increasing with the completion of dams, the filling of new reservoirs, and extension of irrigation. One remarkable feature is the delta "barrage," a low dam across the Nile below Cairo that has raised the water level in the soil over a great portion of lower Egypt and part of the Delta. Other barrages exist further up the Nile.

Except in the Delta region where the Nile spreads out fan wise, the width of the cultivated area for a thousand miles along the Nile is probably 7 to 8 miles or less.

A series of great dams of which Aswan is the best known have been built or are under construction toward the headquaters of the Nile. These are extending the cultivated area.

Cotton, since the time of Mohafed Ali (during the past 100 years), has become the principal cash crop. From our houseboat we saw sail boats and large power driven, flat bottom boats and barges piled high with bales of cotton on the way to Alexandria for export to Italy, England and elsewhere. **The economy of the country is built on cotton.** The Agriculture Ministry devotes much of its research and extension work to that crop. If cotton is of good price the country prospers. When we were in Cairo the price was low and demand poor. Everyone felt the pinch of the resulting depression. War has increased the demand for the time being.

But because of the low prices for cotton of the past few years the government and the leading farmers have intensively studied other export crops, notably fresh fruits and vegetables. **Egypt has a growing citrus industry**, and until the advent of war a fairly profitable one, that specializes on the Mandarin, a small, puffy-skinned, sweet, aromatic fruit somewhat like a tangerine. In that direction also is the development of fresh winter vegetables such as peas, artichokes, asparagus, beans, lettuce, etc. Several exporters and the government Ministry of Commerce are making shipments and testing European markets. On much of the soil three successive crops are grown annually. Tomatoes grown in the winter are excellent for table use and for tomato products. A considerable industry in tomato paste production is being established. Three crops of tomatoes could be grown on the same land each year.

We visited the famous oasis valley of Faiyume that lies many feet below the Nile out in the Libyan desert. It is watered by a canal from the Nile; a canal said to have been built many centuries before Christ by Joseph of Biblical days. Electric power is produced from the water of the canal as it drops into the valley. When we visited the oasis or valley the open spaces of the floor were carpeted with berseem clover, a crop that looks at a distance like alfalfa, but which is an annual. It is sown in October and 4 to 5 cuttings are made during winter and spring. It is fed to livestock green. One sees camels, donkeys and carts laden with it not only in the villages and on the farms, but also coming into Cairo itself. The last crop is allowed to ripen for seed and summer forage.

But also in Faiyume are hundreds of thousands of date palms as well as groves of bananas and citrus and plantations of grapes, olives, figs and pomegranates.

As elsewhere many of the dates are planted more or less helter skelter without much respect to definite plan or variety. Most of the palms are "Balady," that is, native seedlings. Our guide, Mr. El Deeb, a graduate of the University of California, stated that probably over 90 per cent of the dates in this valley were seedlings of poor quality.

He also stated that this unfortunate condition applies to most of the other date growing areas of the country.

So much by way of introduction.

Date Regions of Egypt:- Ghamrawy of the Ministry of Agriculture classifies the Nile Valley as to date production as follows: (a) the maritime subtropical, consisting of the Nile delta and the lower part of the Giza province; (b) the desert subtropical, comprising Upper Egypt to Aswan, together with the Libyan oases; (c) the desert tropical, comprising upper Egypt beyond Aswan to Khartoum in the Sudan.

In general the soft varieties are grown in the maritime subtropical district; the semi dry in the desert subtropical in the Nile Valley and desert oases; and only dry dates in the desert tropical region.

The temperature and humidity conditions are shown in the following tabulation by Ghamrawy:

Locality and Zone	Relative Humidity	Heat units May to Oct. 31 (above 64.4°F)
Alexandria, maritime	--	2049
Lower Giza, "	--	2179
Upper Giza, desert subtrop.	69	2650
Siwa Oasis " "	52	2845
Asyut " "	55	3147
Dakhla Oasis " "	30	3675
Qena Oasis " "	50	3875
Aswan " "	39	4296

Beyond Aswan the heat units increase and only dry dates are produced. Even the Deglet Noor is a dry date in that region.

Date Varieties:- As mentioned in the introductory remarks on Faiyume, the Egyptian date industry is cursed by a multitude of seedling varieties known as Balady dates. Incidentally, there are Balady oranges, Balady olives, etc. Most of the Balady varieties of dates are inferior in size and quality.

In the maritime subtropical region the soft, early ripening varieties predominate. Most of these are eaten soft soon after picking from the trees. Several of these varieties are known to California date growers, of course.

The Hayani is a large date that is almost black when fully ripe. It is popular and is grown throughout the delta. It ripens very early, often during the first or second week of August.

The Zaghloul is a very large variety judging from the picked and preserved dates of this variety seen in Cairo in March. The skin is smooth and dark shiny red in color. It is considered the best date in Egypt for use in the slightly unripe state. It is even then not astringent; is crisp and sweet. It may be shipped considerable distances in that state. It appears late in August and is consumed chiefly in the "Rutab" form, that is, fresh and raw.

While in Cairo we were served jams, preserved dates and pickled

dates of these two varieties.

The Samani is another very important soft date of the Delta district particularly near the sea at Rosetta and Idku. Somewhat smaller than Zaghloul; juicy and non-astringent when slightly immature; used fresh; average yield per tree very high; 387 pounds per palm in tests made in 1935; one gave a yield of 600 pounds. Ripens in late August.

The Amhat is rather small but popular for fresh use in the fully ripe stage. Picked every three days as it ripens, by shaking the bunch on the tree into shallow palm leaf baskets over a period of 30 to 35 days. Some ripened artificially by spraying cut bunches with vinegar, heaping up and covering. Yield is moderate, 190-300 pounds per tree. Some made into pressed dates or Agwa. See later section.

The Siwi is said by Bahgat to be the same as the Saidy. In the oases it is known by the latter name and is used there as a semi-dry date for packing as fancy whole dates or as pressed dates, that is "Agwa" and "Kabees." Fruit medium large. Skin smooth and yellow. Flesh thick and equal to about 87 per cent of whole fruit. Sweet in the slightly unripe, firm stage and much used at that maturity. Not grown in the Delta but in the oases, Giza province and in Faiyume. Much of the crop is converted into pressed dates. Yield per tree, 225-325 pounds; highest recorded yield 390 pounds.

Other soft dates described by Brown and Bahgat are Sofr-El Domain, Atlawi, Erabi, Bint Eisha, Koobi, Kaboosh, and Kattawi. Also the following varieties have been introduced from Iraq by the Ministry of Agriculture for trial for possible future use as soft dates: Barhi, Ashgar, Khadrawi, Halawi and Zahidi. Several of these are well known in California, but evidently until introduced by the government had not been grown commercially in Egypt.

Among the semi-dry dates Brown and Bahgat list the following as of importance:

The Amri is a date of large size grown in the desert subtropical zone. Bulged in center; tapering at ends; nose blunt. Usually picked slightly unripe. Ripened in heaps by stacking bundles overnight. Dried on reed mats at Salhyia, on pebbly gravel at El-Qorein, and on the flat roofs of houses at Marg. Some sold in soft state for immediate use; others dried to semi-dry state for permanent preservation. Popular in Turkey and Germany. Ripens late, in second or third week of October.

The Aglani is grown in Sharkiya Province. Medium size. Dark brown when ripe. Picked by shaking the bunches into shallow mats.

The Saidy is now considered to be the same as the Siwi previously described. In the maritime zone it is a soft date and in the desert subtropical a semi-dry date. It is the principal date grown in the oases. It is considered probably the best of Egypt's date varieties for fancy pack for export and commands good prices for this purpose and for sale in Cairo and Alexandria. According to our former student, A. H. Nouty, chief of date products research in Egypt, a far greater proportion of the Saidy crop could be made into fancy pack by careful proportion of the Saidy crop could be made into fancy pack by careful harvesting, prompt fumigation and dehydration. One difficulty is the long "haul" by camel caravan or by truck over the roadless desert to urban centers. The usual procedure is to dry the ripe dates on palm leaf mats and pack tightly in palm leaf bags as described elsewhere. Most of the fruit appears on the market, if Cairo is a criterion, as pressed dates in a solid mass or cake and is sould from push carts, small street stalls, or from screen covered trays carried on the head.

Brown and Bahgat place the Bara-Kawi at the top of the list of dry dates. Known also as Sakkoti and Ibrimi. Grown in desert tropical zone of Upper Egypt and the Sudan. Medium size. Stone slender. Ripens and dries on the tree. Skin smooth. Reddish brown. Sweet in flavor. Medium to large medium in size.

The Gondeila is small to medium in size; yellow; the stone is wide; flesh medium thick. Dries on the tree. Quality good.

The Garguda is a small to medium size dry date of inferior quality. Flesh thin and somewhat acrid in taste.

The Bartamuda is a rather large date for the dry class. Unequal sided; tapering at ends. Stone long and narrow. High percentage of meat, about 90 per cent. Conceded to be the best of the dry dates. If packed at 1820 per cent moisture is fairly tender. Other dry dates mentioned by Brown and Bahgat are the Dagana and Shamiah.

They state that dry dates are produced chiefly, in fact almost exclusively in the Sudan, Nubia and Aswan, all provinces far up the Nile Valley.

Harvesting and packing are described in a subsequent section.

Cultural Practices:- This report is not intended to cover cultural practices except in very sketchy outline. For good presentations of this subject see Professor Hodgson's paper published in one of your recent Institute Proceedings on dates in North Africa, as well as the comprehensive two Egyptian Ministry of Agriculture publications listed at the end of this paper.

Of great interest to me was the astonishing fact that dates in Egypt will grow and produce fruit (not large crops it is true) in soil containing water that has as much as 30,000 parts per million (3.0 per cent) of salts! I saw date palms alive and of good size growing near Alexandria in soil on the surface of which was an encrestation of salts or white alkali! Brown and Bahgat give analyses of soil supporting fruiting date palms in which the sulfate content (white alkali) was 2 to 5 per cent. The tolerance to sodium carbonate (black alkali) is much lower, namely .06 per cent. Offshoots are difficult to start in such soil; the mortality is high. Seedlings are more easily started.

Naturally the palm prefers sweet normal soil to alkali or salty soil.

As here in California the Egyptian palms are very tolerant of water, and do well even if roots are submerged for long periods in water. Some have remained alive after several years partial immersion in the Assuan reservoir.

Propagation of the better varieties is considered much as in California. I was told by Dr. Bahgat that prices for offshoots are very low. He recommends offshoots of 3 to 4 years ago. In some places the offshoots are allowed to grow into mature fruiting palms beside the mother palm; the family then being known as a "Kosha." I saw a few of these. He and Brown give full details concerning cutting of the offshoots, nursery planting, field planting, care, etc.

Pollination is conducted artificially. While the pollen from one male palm will fertilize the flowers of about 40 female palms, Bahgat recommends not less than one male to each 25 female palms. Some of the ancient bas-reliefs show artificial pollination of the date flowers. Bahgat has done considerable research on methods of differentiating between young male and female seedlings.

He has also made observations on the effect of pollen from different varieties of date palms, and has concluded that size, shape and date of ripening of the fruit can be materially affected by choice of pollen,

even after allowance is made for the well known natural variation in dates on the same palm, or even the same bunch.

Brown and Bahgat recommend thinning of the bunches preferably by removal of 20 to 30 per cent of the strands. They state that this degree of thinning does not reduce the total crop, gives larger fruit, and promotes more regular bearing.

Pruning is necessary, they state, but should not be done while the lower leaves are still green and active. Each leaf is said to produce one pound of sugar a year.

Manuring with pigeon droppings or barnyard manure is quite general. Berseem clover may be grown between the palms and plowed under as a cover crop. Some night soil may be used. In sandy locations it is said that a hole about a yard square may be dug at one side of the palm and filled with pigeon manure, as much as 450 pounds per tree. Or a water buffalo may be tied at the base of the palm to feed on the berseem and to leave droppings to fertilize the soil.

Where the water table is near the surface irrigation may be dispensed with for large well-established palms. Growing palms and offshoots require frequent irrigation for good growth.

For adult palms in ordinary soil the irrigation may be discontinued in November, December and January. Irrigation is resumed in late February, through June and late July. The Nile flood should then raise the water table sufficiently to displace later irrigations. The water may be applied by the basin method, flooding the entire surface, or if water is too costly or scarce, by small ditches between the rows. The latter method was in use in the gardens that we visited.

Cultivations are usually two in number where clean cultivation is practised; one near the end of February and one in summer.

Many of the palms, in fact most of those near Cairo, are very tall. One would guess that labor expenditure for picking would be large, although the cost is not necessarily so since labor is plentiful and low in price in Egypt.

Interplanting:- Berseem clover is often planted between the palms for forage and for use as a cover crop. Vegetables, such as tomatoes, peppers, egg plants, etc., are sometimes grown, particularly between the young palms. In such cases fertilizing should be done regularly.

We saw many mixed plantations, particularly in the Faiyume district, of figs (these as single whip-like stalks), bananas (near Alexandria), olives, limes, oranges and grapes. Such plantations naturally make a heavy drain on soil fertility and fertilization would seem necessary for continued, regular production. Bananas are very heavily fertilized, and the palm would benefit accordingly. The Egyptian banana "tree" is small and seems to grow fairly well between the palms; its fruit is very small but of excellent flavor. The color is pink.

Picking:- As mentioned in previous paragraphs, harvesting practice varies according to the class of dates as soft, semi dry, and dry, and according to the locality.

According to Egyptian statements, the picker climbs the tree barefoot and with a loop of rope around himself and the trunk as a safety belt. He may lower the bunch by rope or hand it down the trunk to a chain of barefoot workmen clinging at regular intervals to the trunk. Or very often he shakes the bunch over a shallow, woven, palm leaf basket into which the ripe dates fall. This may be repeated at three day intervals several times and finally the remainder of the bunch cut and removed to complete the ripening.

Dry dates are left on the tree until they have ripened and dried to a fairly hard condition.

Ripening:- The preferred method appears to be to let the fruit ripen naturally on the tree, hence the frequent picking of the ripe fruit to avoid overripening, souring or excessive drying.

Bahgat states that the Amhat variety is usually picked over a 30-45 day period as outlined above; but that the entire bunches may be gathered slightly unripe and sprayed with vinegar. They are then stacked to ripen, the vinegar hastening the process.

The Horticultural Section has ripened considerable quantities of dates in a closed, warm room after fumigating. After ripening they are dehydrated before packing. In general, however, ripening occurs on the palm or on the bunch after removal from the tree.

Drying:- According to Bahgat, dry dates are left on the bunch until they have passed the ripe stage and have dried naturally to a semi-hard dry state. The bunches are then cut from the palm and allowed to dry several days on the bunch. They are then picked from the strands and spread on a layer of ashes on the ground and turned every 4 to 5 days for a period of about six weeks. They are then stored in heaps or in bags until sold. If in sacks wood ashes are mixed with the fruit. If in heaps ashes are not only mixed with the fruit, but a layer of ashes covers the heap. All of this is to discourage insects, particularly the Ephestia moth. The owner usually takes care of picking and drying.

Brown and Bahgat describe the drying of the semi dry variety Amri about as follows: The bunches are taken from the trees before the fruit is quite ripe. It is picked off the strands and spread on reed mats or pebbles and allowed to dry two to five days. After this treatment they are heaped up each night for 8 to 10 days to heat and ripen. The ripe fruits are taken out each day.

The bunches of the Saidy of the oases, it is said by Brown and Bahgat, are cut when the dates show definite signs of ripening. The fruit is picked off the strands and spread on matting or pebbles to dry. When sufficiently dry it is rinsed to remove dust and sand; again dried for a day and packed as escribed later.

Several dehydraters have now been installed; one by the Horticultural Section of the Ministry of Agriculture in Cairo under A. H. Nouty's direction and several in the oases. That in the Horticultural Section is a Casey dehydrater. In this plant the sound, uncrushed, whole dates as received are placed on wooden tays and given 1½ hours' fumigation in carbon disulfide in a tight room. They are then washed under sprays of water from above and below on a traveling belt. They are then graded from a belt into separate dehydrater trays. They then are dehydrated at 150-160° F.; the upper temperature being applied near the end of the drying period to destroy microorganisms and to inactivate enzymes.

If picked before thoroughly ripe, the dates, as previously stated, are ripened in a room in which temperature and humidity are electrically controlled.

By use of these techniques a high proportion of fancy fruit can be secured; and the Horticultural Section has acquired a favorable reputation for its fancy, carton pack fruit.

Nouty believes that more careful and somewhat earlier picking and the application of dehydration would make possible the building up of an important export market for high quality Egyptian dates. Some of the proceeds so obtained could be applied to importing low priced dates from Iraq for Egyptian use or to expanding Egyptian production.

Processing and Packing:- Processing and packing of dry dates is very simple and has been outlined in a previous paragraph.

Brown and Bahgat describe the packing of the Saidy (Siwi): The dry dates are dipped in water to rinse off sand and dust and are dried again in the sun a short time. They are then placed layer by layer into a palm leaf basket in a hole in the ground. A rope passes around and beneath the basket to lift it after filling. As each layer of fruit is put in the basket (known as a "gamba") a circular mat is placed over the fruit and the dates beneath pressed tightly together by pressure of the feet on the mat. The mat is known as a "bursh." When the basket is heaping full a clean "bursh" is sewed over the top. One sees stacks of these large covered baskets of dates in the markets. The fruit so packed is known as "Kabees."

Pressing the fruit tightly discourages insect larvae. The solid mass is cut into pieces of convenient size for retail sale by the "chunk" from push carts, street stalls, groceries or from screen covered trays carried on the head.

The making of "Agwa," another kind of solid pack, is described about as follows by Brown and Bahgat. The dates of the Amhat variety are pitted by hand and placed in a heap on palm leaves or on matting. Dry palm leaves are placed over them and kept moist. They are then worked into a solid mass with the feet (I assume a piece of matting is placed between the feet and the fruit). The surface is smoothed over and the dates allowed to cure. Later the mass is cut and packed tightly into large, rather slender, woven palm leaf baskets, called "fards."

Syrup may be expressed from the Agwa by pressure applied to the bag suspended from poles. The syrup is used as a "honey," or whole dates may be stored in it in open vessels in the sun. Evaporation occurs and the dates absorb the syrup, developing so it is said, a pleasing flavor.

In one of the commercial canning and packing plants in Cairo we witnessed the packing of Saidy dates. The dates were spread on trays; fumigated with carbon disulfide; washed; dehydrated, sorted and packed in cartons. The dates came in by camel caravan from the oases.

At the Horticultural Section of the Ministry of Agriculture much of the pack was of pitted dates. A pitting machine made by the Elliott Machinery Company of Fresno is used. The pitted dates are pressed into open wooden forms resting on a smooth surface. The surface of the pack is ridged to appear like rows of closely packed whole dates and is wrapped in cellophane or lithographed paper. These packages retail at about 2 piasters per kilogram or about 5 cents American per pound. The wholesale value of Mesopotamian dates is given by Bahgat at 1.7c a pound as imported into Egypt. I remember that we were given an amazingly large slab of "Kabees" for a piaster, 5 cents American; not less than 2 pounds.

Some of the fancy quality fruit is packed in lithographed cartons, the dates being arranged in neat rows with a piece of the fruit strand between them.

The dates for fancy pack, also, may be hand polished.

Some of the soft dates are partially dried and packed tightly into stoneware jars. The tight packing as is the case with "Kabees" and "Agwa" discourages insect larvae.

Some are dried in ovens usually on a small scale for home use and are known as roasted dates

At the Baharia Oasis the Ministry of Agriculture maintains an experimental station where considerable work is done with dates. The Saidy dates at the station are fumigated in carbon disulfide; washed; trayed; dehydrated at about 150° F. and when nearly dry, are heated to 160° F. for about an hour to sterilize them. They are packed neatly in layers in circular friction top cans or in oblong cartons. The aim is to pack them at 21-24 per cent water. The Saidy that I saw is a medium size, light brown, square-shouldered date with a fairly large pit.

In the station in Giza the refractometer method is used for moisture determination. We suggested that the California Dried Fruit Association's electrical conductivity moisture tester be used also.

Special Date Products:- Nouty of the Horticultural Section gives the following formulas for several date products:

Date Brittle

2 pounds of sugar
½ pound of glucose syrup
¾ pint of water
Pitted dates. Vanilla extract

Put the sugar, glucose and water in a kettle; stir; bring to a boil. Cook to 275-280° F. Flavor with vanila. Put pitted dates on an oiled slab. Cover with the hot syrup. Let harden. Cut into pieces. The dates must be quite dry.

Date Ice Cream

1 quart of cream
¼ cup of sugar
1½ teaspoon of vanilla extract
2 cups of pitted, ground dates

Soak dates in the cream several hours. Add sugar and flavor. Mix well. Freeze.

Date Syrup

Use cull dates. Wash well. Soak in water overnight. Remove pits. Boil until soft, adding water if needed. Drain through a muslin sack. Boil down in an open pan to a syrup.

Stuffed Dates

Prepare a fondant by cooking 1 pound of glucose syrup and 9 pounds of sugar to soft ball. Cool. Stir until a soft fondant is secured. Add 5 pounds of ground almonds. Mix well. Flavor and color to suit. Stuff pitted dates (dates slit down one side and pit removed). Dehydrate if needed. Candy the surface by storing in 33° Baume heavy cane syrup. Drain.

In every Egyptian home in which we dined, we were served home made date conserves, spiced dates and date jam. All were delicious in flavor and well made. The following is a recipe given me by Madame Fahty Bey, mother of Mr. El Saifi, a graduate of Fruit Products of the University of California.

"Use whole, dry dates of semi-dry type. Cook in water to soften. Remove peel and pit. Add ½ cup of sugar to 1 cup of dates. Then add the water in which the dates were cooked. Add a little lemon juice. Put a clove in each date. Cook slowly to a heavy conserve."

In another recipe the lemon juice and spices were omitted and a generous quantity of chopped walnuts was added near the end of the cooking period. In this case, the finished product was a very heavy, rich jam.

Date preserves are also packed in flavored syrups such as rose petal syrup of very heavy density.

Dates unfit for human food may be fed to camels. I was told that camels like date stones! But I am afraid someone was "stringing me," for there appears to be about as much nourishment in a date pit as in an empty tin can. However, after grinding to a meal they may be fed.

It is said that a coffee-like product is sometimes made by roasting the dry dates and pits. I did not see the product.

I sampled "araki" or date arrack made by a "moonshiner" of the desert and brought a sample home with me. It is made by distilling the fermented water extract of cull dates in the presence of anise seed. It is

highly flavored with anise. To drink it one dilutes it very, very generously with water. The oil of anise separates in the water as a milky cloud. "White mule" is a mild beverage in comparison! Good Moslems do not drink it or other strong liquors; but those of other faiths are numerous enough to provide a market.

A wine-like drink is sometimes obtained by making a hole in the top of the palm, collecting the sap and fermenting it.

The Horticultural Section also packs fresh semi-dry dates by pasteurization in glass and in tin in about the same manner as done in Coachella Valley. Also fresh soft dates of higher moisture content were successfully packed in light syrup and sterilized in sealed containers at 212° F. Considerable reddening of the color occurs.

Semi-dry dates have been successfully conditioned by immersion in syrup.

The Horticultural Section is packing pitted coarsely ground dates for use in baking, candy making and for other purposes.

Palm Leaf Products:- As other visitors to Northern Africa have reported to you, the dried leaves are woven into baskets and mats used universally for many purposes. They are of all sizes and shapes and very durable as well as absurdly low in price. Hats may also be made of them. The reddish fiber at the base of the stems is carded by hand and woven into small rope. The rope is often used for making into side bags for use on donkeys and camels for carrying produce, soil, fertilizer, children, etc.

Young fronds are sometimes beaten into a pulp and twisted into rope.

The mid rib is dried and cut into strips of rectangular cross section with very sharp hatchets or machetes. Holes are bored or punched in the larged pieces and cross pieces inserted through them to construct strong crates of delicate pattern. These are used for transport of all kinds of fresh produce from oniors to mandarines. They are almost indestructable and their cost is low. We saw teams of father and son making them on the sidewalk near the markets. With simple tools, they made these containers "in almost no time at all!"

The mid ribs are also trimmed, cut and fabricated into bedsteads, chairs, tables and benches.

The dry fronds are used as a covering for low trellised grape vines in Faiyume; or as a thatch for peasant homes.

The trunks are cut into a rough lumber used in making doors, rafts, seats, pergolas, etc. It is very durable. We saw men cutting out such boards on a large farm by hand with a two-man cross-cut saw.

We have already spoken of the large date leaf woven baskets used as containers for "Agwa" and "Kabees" pressed dates.

Egypt has scarcely any native timber suitable for lumber; hence the necessity of making such good use of date fronds and leaves.

Acreage, Number of Trees, Imports, etc.:- Egypt has about 5,000,000 date palms, although in 1907 the census showed 12,000,000 (figures by Brown and Bahgat). The filling of the reservoir behind the gigantic Aswan dam inundated a great number. Egypt rates sixth among the date growing countries in point of number of date palms. Iraq (Mesopotamia) has 30,000,000, Algeria 10,500,000, Persia 10,000,000, Arabia 9,000,000 and Tripoli 10,000,000.

I failed to obtain any data on the total annual production of dates in Egypt. If one were to allow a production of 100 pounds per tree the total would be about 500,000,000 pounds; or about 250,000 tons or about the amount of prune production per year in California. The per capita consumption would then be about 31 pounds.

Relatively few Egyptian dates are exported. In fact the country imports about 22,000,000 pounds of dates from Iraq, chiefly from Basra.

The buying power of the great majority of the people of Egypt is very low. There is no great middle class as in America and some European countries. The very poor can pay but little for its dates and cannot be very particular as to the presence of insects, sand, etc.

As previously stated, the Ministry of Agriculture hopes by replacing the Balady seedling dates with better varieties propagated by off-shoots and by improved methods of drying, processing and packing, to place the industry on an export basis, rather than the present import basis. As part of this program, the aim is eventually to develop an important industry in the packing of fancy dates for export.

Notes on Rentals, Etc.:- The owner or renter pays the Government about 2 pounds Egyptian (about $10.00 American) per acre annually for water and police protection. At sundown everyone comes in to the village from the fields or the groves: to be found in the fields after dark is to risk being shot by the Government night police. In the Faiyume we saw the long stream of camels, big wheeled carts, donkeys, oxen, water buffalo, men, women and children trudging to the villages and the night police with wicked looking double barreled shot guns going out on night patrol.

I was told the rental for good land for growing cotton, berseem clover, vegetables, wheat and other crops is about 8 pounds Egyptian or about $40 per acre per year. The range for the country is about $15.00 to about $60.00 per acre for good land, I was told by a government irrigation engineer. Poor land may rent for a little as $7.50 an acre. A tax of about $1.00 to $2.50 for support of education, hospitals, etc., is also levied.

A renter often has about two acres of which about 1 acre is in cotton, one-half acre in corn for human food and animal fodder, and one-half acre in clover. The cotton is the cash crop and pays the rent. The berseem feeds the live stock and adds nitrogen to the soil. Some berseem is sold green in the cities for city live stock such as cab horses, donkeys, buffalo, and camels. Vegetables for home use are grown after the clover is removed, and in the winter before the cotton and corn are planted. The peasant (fellah) needs little cash and raises practically all his needs.

The government has built the various dams and controls the entire irrigation system of the country. Before construction of the dams the land was flooded during the summer in the time of the Nile flood and during the remainder of the year suffered for water. In land served by the barrage the water table is high and pumping is used to elevate the water to the fields. This may be done by hand with a "shadouf," a bucket hung to a long pole pivoted on an upright post and counterbalanced by a weight at opposite end; or by "sakieh" ("sakhia"), a water wheel with pots or buckets on its periphery and operated by an ox, camel, donkey or buffalo; or by an Archimedes screw, "tambour," a wooden cylinder with inner helical screw. The lower end of the cylinder rests in the ditch of water and is turned by hand. The screw conveys the water the few feet to the land. Ditches are numerous and well cared for, and irrigation is well administered. Some of the large farms are now using power driven pumps also.

The "feddan," which is 4,200 square meters, is the customary unit of land

measurement used in preference to acre or hectare.

Dates may be purchased on the tree by merchants, or the owner may harvest and cure the crop before offering it for sale; or he may rent the land and the date palms to others, in which case he and the renter share the costs and the crop. In some cases a man contracts to furnish pollen for pollination, do the pollinating, furnish guards, care for the fruit until harvest and harvest it, receiving one bunch per tree as his pay. In other cases there may be three owners, namely, the owner of the land, the owner of the well, and the owner of the palms, to divide the crop between them. On the oases, I was told, a family may own only 3 or 4 trees. Because of small holdings and lack of care and sanitation in picking, drying and packing at the groves, it is difficult to secure cooperative effort or to improve the general average of the crop.

DATE PRODUCTS EXPERIMENTS AT UNIVERSITY OF CALIFORNIA

Owing to the fact that I have been rather extravagant in use of words and space for Egypt, and since our present studies on date products are far from completion, I shall be very brief on this subject.

Value of Wax Wrappers:- By way of introduction we shall mention two early pieces of work. Christie in this laboratory in 1925 showed that properly applied wax wrappers markedly retarded drying out and sugaring of carton packed dates, and greatly reduced insect infestation over a storage period of 493 days. Later about 1930-33, Nichols and Mrak extended this work to other packages and wraps.

Changes in Processing and Drying:- Another early piece of work was that of Shallah (a student from Mesopotamia) and the writer on changes in dates during artificial ripening and dehydration (See Jour. Plant Physiology, July 1927). Mesopotamian grown dates were found to be somewhat higher than the California grown of the same varieties in sugar and lower in moisture. Dehydration at not above 120° F. was found the most satisfactory means of artificial ripening. Loss of tannin, inversion of sucrose and other changes proceeded rapidly at that temperature.

In Ice Cream:- In experiments made about twelve years ago formulas for dried fruit ice creams including dates were studied by our division and that of Dairy Industry. We believe date ice cream is a "natural" and should be better known both as home made and as commercial ice cream. Pitted chopped dates with or without chopped walnuts are added to the basic mix and stirred or whipped in during freezing. The dates should not be too dry.

In Candy:- In our Extension Circular 10 we have given a number of formulas for dried fruit candies in which pitted dates as well as other dried fruits were used. We mention puffed date fondant and date-nut-arctic-ice candy as of considerable promise among those covered in the circular.

More recently we have worked upon candy base mixtures. One of these is ground medium soft dates 4 parts, "sweetose" (a new thin corn syrup) 1 part, and chopped walnuts 1 part. Mix. Form into pieces of desired size. Roll in chopped or ground coconut. Another makes use of invert syrup in place of "sweetose." Various other "binders" such as gelatin, agar agar, a stiff pectin jelly, or fondant may be used in making the candy base. Arctic ice or chocolate coatings may be used. However, the date industry has done well more than we with date candies.

Date Nut Mix:- This is a mixture of coarsely ground dates of low enough moisture content to keep, chopped nuts and thin fondant, or invert syrup or "sweetose" or other preventive of sugaring; packed in cans or jars unheated for use in cake fillings, candies, date rolls, home made ice cream, frostings, etc. Must be low enough in moisture to keep, or must be sterilized by heat.

Date Brandy:- By usual procedure in use for other dried fruit brandies, ferment a mixture of water and crushed dates to give about 8 to 10 per cent alcohol. Pure yeast and 100-150 ppm. of SO_2 must be used to prevent souring. Draw off liquid. Press. Distill to 140 proof. Dilute to 90 to 100 proof. Age in oak. Quality fair but not so good as best grape brandy. Can be flavored with anise to give arrack if desired but special government permit needed. All brandy operations subject to severe government regulation, supervision and permit. Penalties extremely severe for violations. Get straight with Uncle Sam before undertaking brandy making.

Date Wine:- Cull dates make a fair sherry and poor dry wine. We fermented a mixture of crushed dates and water with pure yeast and 125 ppm. of SO_2 and 0.5 per cent citric acid several days. Pressed. Completed fermentation in small barrels to dryness (free of sugar). Filtered some and aged in oak to a fair to poor table wine of about 12 per cent alcohol and aged in oak to give a sherry like product of fair quality. Addition of citric acid is needed to give a pleasing tartness.

Grape sherry is low in price; whether date wines would find a market is doubtful.

Date Syrup:- When dates were extracted with boiling water and the extract filtered and concentrated to a syrup, the latter was cloudy and jeilled. We found in tests made by Jas. Pouting, a graduate student, that a clear syrup that does not jell could be made if the water extract were treated several hours or overnight with Pectinol, a pectin splitting enzyme. Some of the syrup was made in an open cooker and some in a vacuum pan. Both were excellent in color and flavor at about 68° and Suitable for table use. Our tests indicate that the syrup could be made in simple, open sorghum or maple syrup pans, or in a steam-coil-heated, open "boiled cider" pan.

We believe the product has real merit and commercial possibilities. If a wholesale price of $1.00 to $1.10 a gallon could be secured as for other medium priced syrups it should bring a fair return. One ton of dates should yield about 125 gallons of syrup. It would not be a "gold mine" but might use culls to advantage.

Spiced Dates:- Dates packed in medium heavy syrup containing vinegar to give about 2 per cent of acetic acid in the syrup or about 1 per cent after equilibrium with the fruit is attained. A few cloves and pieces of stick cinnamon are added for flavor. Pasteurize at 180° in glass after vacuum sealing.

Conserves:- A heavy preserve was made with choice quality Deglet Noor dates by cooking a short time in Sweetose syrup and packing hot in glass or tin. Prolonged heating causes reddening.

Butter:- Ground pitted dates, plus invert syrup or sweetose corn syrup plus powdered cloves, allspice, and cinnamon to taste. Cooked to a butter consistency and packed hot.

Jam:- Made as for butter except spices (or most of them) are omitted and the mixture is cooked to only a medium consistency. Better if dates are coarsely ground or chopped, not finely ground. Walnuts may be added. Probably best if made with peeled, pitted, fresh dates as is done in Egypt.

Breakfast Cereals:- We have devised fairly satisfactory formulas for breakfast cereals made with diced fruits, whole wheat flour and other

ingredients. Formula on request. The date flakes made in Southern California are, however, probably more desirable than our product.

Fresh Dates in Syrup:- A few experiments made several years ago in this laboratory and the experiments of Nouty in Egypt indicate that fresh dates sterilized in syrup in cans or jars may be worthy of development.

Research on Souring and Sugaring:- Dr. Mrak and Dr. Vaughn of our Division are studying intensively the souring and sugaring of dates, but unfortunately, have not progressed sufficiently to report at this meeting. As a matter of fact, my talk of today is largely in the nature of "filler-in" for them. They have promised to report to you a year hence.

In General:- We shall continue our tests on new products, and shall be glad to be of any assistance possible to those of you now engaged in preparing and selling date specialties. I've been very favorably impressed with the progress made by the several manufacturers in this Valley and in other places in the southern part of the state with date paste, date crumble, pitted dates, date rolls, date flakes, etc. In fact, you have done much more than we in this field. We should probably consider date products as one means of crop control by providing an outlet for the lower grades and by keeping such off the market as competitors of the packed dates. Finally, I wish to compliment the date industry for its ingenuity, enterprise and perseverence in devising and developing a number of excellent date products that should in time take most of the fruit unsuitable for the better grades of packed dates.

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Fruit Thinning of Dates In Relation to Size and Quality

By Roy W. Nixon, Associate Horticulturist, Division of Fruit and Vegetable Crops and Diseases, U. S. Bureau of Plant Industry, Indio, California

Of all the operations by means of which the date grower can influence the size and quality of fruit, thinning has the most obvious and direct effect. A knowledge of what happens when fruit is thinned in various ways is essential if the thinning procedure is to be intelligently adapted to the variations in size, type and number of flower clusters that occur within a variety or between varieties. This paper is an attempt to summarize the results of a study of different methods of thinning begun at the U. S. Date Garden in 1934 and still under way.

The fruit of the date palm may be thinned by reducing either the number of bunches per palm, the number of strands per bunch, or the number of fruits per strand. Practically, of course, there may be variations in the distribution of the bunches, strands, or dates removed, and such variations and combinations between them make possible a number of different methods of thinning. Reducing the number of bunches per palm will be referred to as "bunch removal;" reducing the number of strands per bunch or the number of dates per strand will be considered together as "bunch thinning."

Bunch Removal

In most parts of the Old World bunch removal is the only method of fruit thinning employed with dates, the number of bunches retained being determined by the size and vigor of the palm. The depressing effect of a heavy crop one year upon flowering the next year has already been shown, but it is important to know whether the removal of entire bunches affects the size and quality of the remaining fruit during the same season.

In an experiment in 1934 with only two Deglet Noor palms in each treatment, bunch removal was found to increase the size and improve the quality of the fruit retained, but the effect was less than that obtained by bunch thinning.

The data in Table 1 show that reducing the number of fruits 50 percent by bunch removal increased the fresh weight per fruit 20 percent, whereas reducing the number of dates per palm 25 percent by bunch thinning resulted in a 26 percent increase in fresh weight per fruit. The percentage of culls was reduced with 50 percent bunch removal but not any more than with 25 percent bunch thinning. Whether further reductions in the total number of bunches would result in larger fruit and fewer culls on the unthinned bunches retained has not been determined experimentally, as it has appeared impracticable to include such treatments on a large scale in subsequent experiments. However, observations on palms that have carried only two or three unthinned bunches indicate that it is not possible, at least on Deglet Noor, to eliminate without bunch thinning a large proportion of prematurely shrivelled dates.

TABLE 1

Increased size of fruit resulting from bunch thinning as compared with bunch removal

	No Thinning, all bunches left	Bunch Removal ½ fruit removed	Bunch Thinning ¼ fruit removed
Weight per fruit, gms.	6.6	7.9	8.3
Culls - percent	41	29	29

More convincing evidence of the effect of bunch removal on the size and quality of fruit retained has been obtained from a much larger experiment begun in 1939 in cooperation with Mr. W. C. MacIntosh in his commercial planting of Deglet Noor about four miles southwest of Indio. This experiment was designed to study the effect of age and number of leaves per bunch on size and quality of fruit. All palms were pruned to the same number of leaves, 30 plus the current season's growth; all bunches were uniformly thinned to the same number of fruits per

bunch, approximately 1000; and the number of bunches per palm was reduced to 2, 3, 4, 5 and 10 in different treatments to give different numbers of leaves per bunch. Of course this is a two-year experiment for with such drastic leaf pruning the data cannot be finally evaluated until the end of that period. Also, the September rains, which caused a loss of about 60 percent of the crop, made it impossible to secure some of the data desired. However, although further study must be made before a report can be given on the factor of age of leaves and all of the data in hand are subject to revaluation at the end of 1940, the results show that increasing the number of leaves from three leaves per bunch to 7.5 leaves per bunch increased the size and quality of fruits, as shown in Table 2, for the palms that carried 1938 leaves plus those coming out in 1939.

TABLE 2

Effect of number of leaves per bunch on size and grade of fruit

Number of leaves 1938, per bunch	3	6	7.5	10
Fresh weight per fruit, gms.	7.8	8.9	9.7	9.7
Grades B-1 and B-2, percent	35	54	59	72

The results show clearly an increase in size of fruit due to bunch removal and a consequent increase in number of leaves per bunch up to 7.5, but no increase beyond that point. While rain affected the grades adversely, it was apparently worse on the larger fruit, so that there is every reason to believe that the results of the grading represent an upward trend which would probably have occurred even without rains.

It appears from these results that the number of leaves per bunch is an important consideration in fruit thinning. In the leaves are manufactured the plant foods that become the sugar of the fruit. While we have yet to evaluate the factors that determine the efficiency of leaves, there can be no doubt as to the importance of number of leaves. To obtain a proper balance between number of leaves and quantity of fruit is a major objective in thinning.

Bunch Thinning

The superiority of bunch thinning to bunch removal as a means of improving size and quality of fruit has already been indicated, but bunch thinning is also desirable for mechanical reasons alone. Unthinned bunches of dates are so heavy that most of them require special propping and even then it is difficult to avoid a rather large percentage of broken fruit stalks. Also, with most varieties of dates and with most bunches on a palm the removal of some entire strands from the center of a bunch is desirable to facilitate handling the bunch in picking and to permit better ventilation in the center, where the percentage of blacknose is commonly highest and souring most likely to occur in humid weather. This, plus the usual occurrence of shrivelled dates on the tips of the long strands characteristic of Deglet Noor, was responsible for the evolution of the present method of thinning that variety; the tips of all strands being cut back at time of pollination and either then, or in most cases a few weeks later, a certain proportion of all the strands being entirely removed from the center.

To study the present method of bunch thinning as practiced with Deglet Noor dates, comparisons have been made with other methods, practicable or impracticable. Many data have been accumulated which can very well be omitted here with a few comments. Removing entire outer strands and removing strands distributed throughout the bunch have been less effective in sizing fruit and in improving quality than cutting out the center strands and either method requires more time for the operation and obvoiusly fails to open up the center as desired. Removing individual dates distributed along the strand and reducing the number of dates per strand by cutting back the tips have shown very little difference as far as the Deglet Noor variety is concerned; so there is no justification for the additional time and expense required for removing individual dates. For Deglet Noor no other method of bunch thinning has proved superior to the one now in commercial use.

Since all methods of bunch thinning involve either strand removal or thinning on the strand or both, it is important to compare the two separately in order to evaluate their effect on size and quality. Table 3 gives typical results showing larger fruits from cutting back tips of strands than from removing entire strands from the center of the bunch.

TABLE 3

Cutting back tips versus strand removal with number of fruits per bunch reduced 50 percent by each method on Deglet Noor

						No thinning	Strands removed	Tips cut
Fresh weight per fruit, gms.,	1935	(average of	4	bunches)		6.3	8.7	9.3
Shrivel, percent	"	"	"	4	"	41	9	4
Blacknose, percent	1939	"	"	7	"		3	10

Either method has produced larger fruit than no thinning but cutting back the tips has increased the fresh weight 5 to 10 percent more than an equal amount of thinning by cutting out entire strands. Cutting back strands has generally been somewhat more effective in reducing shrivel, but on the other hand removing entire strands has resulted in less blacknose. Since considerable amounts of both shrivel and blacknose do not normally occur in the same year and since it is impossible to predict the character of the season in advance, it seems undesirable on Deglet Noor to thin by either method alone, but preferable to use the two in combination in accord with present commercial practices.

Table 4 is a brief summary from experiments reported in detail at previous Date Institutes and included here to show the effect of amount of thinning on size, grade and yield per bunch of Deglet Noor fruit. Any thinning has decreased total yield, but moderate thinning increased the yield of A and B grades as compared either with no thinning in 1934 or with light thinning in 1935. Although heavy thinning gave further increase in size of fruit and in some instances slightly increased the percentage of higher grade fruit, any such advantage was not sufficient to offset the greatly reduced yield.

Other Factors Affecting Fruit Size

Other factors affecting size of fruit have been evaluated. A large bunch normally carries and matures more fruits than a small bunch. Tests made in 1935 showed that when both were thinned to the same number of fruits large bunches produced fruit somewhat larger than small bunches. Apparently the size of fruit stalk limits the rate of food intake. Therefore, to satisfactorily size fruit, more fruit may be left on a large bunch than on a small bunch.

The larger and thicker strands usually carry and mature more fruits

than the smaller and thinner strands. In a number of different tests it was found that when both were thinned to the same number of fruits, the larger strands produced fruit somewhat larger than the smaller strands.

Shrivel of Halawy

Deglet Noor has been used in these experiments more extensively than any other variety and the results as already outlined have been fairly consistent with that variety. However, experiments have been made from time to time with two soft varieties, Halawy and Barhee, to determine whether the method of bunch thinning used for Deglet Noor is equally well adapted to them. The results with Halawy have not been consistent. Bunch thinning has resulted in larger fruit than no thinning, but the effect of thinning on size has been complicated by an increase in shrivel associated with thinning. This does not occur every year, but when it does occur, as shown in Table 5 for 1936, it constitutes a considerable hazard from any very severe cutting back of tips.

Effect of Cutting Back Tips of Strands in Increasing Shrivel of Halawy Fruits

A comparison of different strands on the same bunch shows that shrivel was increased by cutting back the tips. As between different methods, cutting back the tips of strands compared with the removal of either entire strands or individual fruits almost doubled the amount of shrivel. The higher fresh weight per fruit from the removal of individual fruits on the strands with Halawy indicates an advantage for this method that as been substantiated by other data, but it is questionable whether it is sufficient to justify the additional expense of thinning by that method. The results indicate that with Halawy most of the thinning should be done by removing entire strands with relatively little cutting back of tips of strands. The Halawy bunch is characterized by shorter and more numerous strands than that of Deglet Noor, so that the mechanical objectives of thinning are best attained by depending more upon strand removal in thinning that variety.

TABLE 4

Effect of amount of thinning on size, grade and yield per bunch of Deglet Noor fruit — Commercial method of bunch thinning

	Approximate amount of fruit removed			
	No thinning	Light thinning ¼	Moderate thinning ½	Heavy thinning ¾ - 2/3
1934				
Size - fresh weight per fruit - gms.	7.7		9.8	12.3
Grade - percentage of A and B fruit			58.6	58.9
Yield per bunch of A and B grades, lbs. (calculated)			11.2	8.6
1935				
Size - fresh weight per fruit, gms.		9.4	10.8	12.9
Grade - percentage of A and B fruit		38.1	44.9	47.8
Yield per bunch of A and B grades, lbs. (calculated)		6.0	6.6	4.8

Note: Minimum size of 55 dates per lb. is equivalent to 8.2 grams per date.

The results of bunch thinning of Barhee have generally been intermediate between those obtained with Deglet Noor and Halawy. Shrivel has been increased by cutting back the tips of strands but not to the same extent as in Halawy. Although the results are not as consistent as with Deglet Noor, size has been increased more by different amounts of thinning with Barhee than with Halawy.

The Barhee has a heavier fruit stalk, with strands more numerous and about the same length as those of Deglet Noor. Experimental data, as well as mechanical considerations, indicate that with Barhee the greatest yield of first grade fruit should result from a thinning method intermediate between that for Deglet Noor and that for Halawy.

SUMMARY

1. Size and quality of fruit can be increased either (1) by increasing the number of leaves per bunch by bunch removal, or (2) by reducing the number of fruits per bunch by bunch thinning.

2. The commercial method of thinning Deglet Noor fruit by cutting back the tips of all strands and removing some entire strands from the center of the bunch has given better results with that variety than any other method of bunch thinning.

3. With Halawy, a soft date, cutting back the tips of srands has increased shrivel in dry seasons, so that with this variety it appears safer to remove more entire strands from the center of the bunch and cut back the tips less than is done with Deglet Noor.

TABLE 5

(A) Different amounts of fruit removed by cutting back the tips of different strands on the same bunch of Halawy (average of 3 bunches)

Percentage of fruit removed per strand	0	25	50	75
Fresh weight per fruit, gms.	9.0	8.7	8.1	7.6
Shrivel, percent.	30	42	54	45

(B) Cutting back tips of strands compared with strand removal and individual fruit removal with number of dates per bunch reduced 75% by each method—Halawy (average of 4 bunches)

	Tips cut	Center strands removed	Fruit distributed removed
Fresh weight per fruit, gms.	8.9	9.0	9.6
Shrivel, percent.	42	18	22

The Place of Coachella Valley In the World Date Industry

By John B. Schneider, Extension Specialist in Marketing and Associate on Giannini Foundation, University of California, Berkeley, California*

INTRODUCTION

YOU all know that dates have been produced for many centuries. The development of this industry throughout the ages would be exceedingly interesting. But for the present I wish to confine myself largely to the more recent developments and then only to those developments which concern economic factors of the industry.

PRODUCING COUNTRIES

First let us consider where dates are produced at the present time. The main producing sections are around the Persian Gulf in the countries of Iraq (formerly known as Mesopotamia) and Iran (formerly called Persia). The next largest producing area is in North Africa, principally in Egypt, Algeria, and Tunisia. Finally, we come to the United States with its producing areas in California and Arizona. Some dates are also produced in other areas of the world but they do not enter into commerce in any significant quantities.

It is generally accepted that Iraq and Iran produce the largest proportion of the world date supply. I indicated that is the report, because definite information concerning production is not available for Iraq, Iran, and Egypt. Fairly definite estimates can be made for Iraq and Iran because dates from these two countries constitute an important part in international trade in dates. Estimates for Egypt are more difficult to make, but the United States Department of Agriculture estimated in 1927 that there were 6,700,000 palms in Egypt. You can see that even with a modest production per tree the total production would be large. However, omitting the production in Egypt due to lack of definite information, it is estimated that the production in Iraq is about half of the world production. Iran produces about one-fourth of the total, Algeria about 10 per cent, Tunisia about 3 per cent and the United States about 2 per cent.

TRENDS IN PRODUCTION

Though definite information concerning the trend of production is not available for Iraq and Iran, some conclusions may be drawn on the basis of the trend in exports. This, of course, is not an accurate method of estimating trends in production, but it may be helpful. There may be some doubt that production in Iraq has expanded. At least total exports have increased. The absence of recent information concerning exports from Iraq make it impossible to use even this basis of estimating production.

Production data have been reported for Algeria, Tunisia, and the United States. The production of dates is slowly declining in Algeria due to a combination of causes. The average production for the five years, 1929-1933, was approximately 300 million pounds and the average for the next five years, 1934-1938, dropped to about 224 million pounds. Production in Tunisia except for variations due to climatic factors has held fairly constant.

Production in the United States has increased from 45,000 pounds in 1915 to a maximum of 8,190,000 in 1936. Since 1936, production has dropped somewhat due to unfavorable climatic conditions. However, the upward trend in bearing acreage in California where the bulk of the United States crop is produced, doubled during the last five years. It increased from 1,431 acres in 1935 to 2,850 acres in 1939, thereby materially increasing the productive capacity.

EXPORTS

Supplies from all producing areas do not enter international trade. In all countries only a small proportion of the production is exported. However, Iraq ships the largest percentage of its crop—about 25 per cent of the total crop. It is estimated that about 10 per cent of the production in each of the countries, Iran, Algeria, and Tunisia, is exported. Very little is exported from Egypt. The United States, which is not considered an exporting nation, did export in 1937 almost a million pounds of domestic dates. This was about 13 per cent of the total production. The first domestic exports reported amounted to 312,136 pounds in 1935. They increased to 447,583 pounds in 1936 and 968,142 pounds in 1937.

More than three-fourths of all the dates entering into international trade are produced in Iraq, about 15 per cent in Iran, about 6 per cent in Algeria, 2 per cent in Tunisia, and only about $\frac{1}{4}$ of one per cent in the United States. A large volume of dates exported from the producing countries is shipped via other countries before finally being imported into the countries where they are finally consumed. However, it is rather difficult to trace all the trade routes which all these shipments follow.

IMPORTS

Considering only the dates which enter international trade, India is by far the most important importing country. It secures most of its supplies from Iraq. The United States and United Kingdom are probably next in importance as consumers of imported dates. Practically all of the United States imports originate in Iraq. Until about 1935 some of the imports came by way of the United Kingdom, but since then they have been coming direct from Iraq to the United States. The United Kingdom also secures the bulk of its supplies from Iraq, although sizeable quantities come from Algeria via France. The next most important source tapped by the United Kingdom is Iran. Although Egypt and Algeria are important producers of dates, they also import large quantities from Iraq. France is also an important consumer of dates which are imported from North Africa and Iraq. Arabia also imports large quantities of dates from Iraq.

Statistics relating to the trend of imports entering the United States may be of special interest to you. As early as 1909, over 20 million pounds of imported dates were consumed in the United States. The maximum was reached in 1925 when over 66 million pounds of imported dates were consumed. Since then the amount has fallen off somewhat. But even in 1938, about 85 per cent of the total consumption consisted of imported dates.

Many factors are responsible for the fluctuations in imports. One of the factors which we often think of as having an influence is the rate of import duty. Prior to 1922 the duty on dates was one cent per pound. The Tariff Act of 1922 classified dates into two groups—fresh or dried, and prepared or preserved. The rate on

*Dr. S. W. Shear of the Giannini Foundation and G. B. Alcorn, Extension Specialist in Marketing, rendered valuable assistance in making this report possible.

fresh or dried dates remained at one cent per pound and the duty on prepared or preserved became 35 per cent ad valorem, which in effect amounted in the period, 1922 to 1930, to approximately 1½ cents per pound. The Tariff Act of 1930 still further subdivided date imports into four classifications. The former first classification of fresh or dried was subdivided into three special classifications, consisting of (1) fresh or dried dates with pits at one cent per pound if packed in packages of more than 10 pounds, (2) fresh or dried dates similarly packed but with pits removed, at 2 cents per pound, and (3) if either with pits or without pits and packed in packages of not more than 10 pounds, the duty became 7½ cents per pound. The duty on prepared or preserved dates remained 35 per cent ad valorem. As a result of the reciprocal trade agreement with France which became effective in 1936, the duty on prepared or preserved dates was reduced to 25 per cent ad valorem. However, only a small percentage of the total imports fall into this classification—approximately 10 per cent in 1937. That same year about one-half of the dates were imported with pits; about one-third were imported with pits removed. Only a very small amount, less than 3 per cent of the total imports, was in the small-sized containers of 10 pounds or less.

Other factors beside the import duties have an influence on the international movement of dates. For example, during the World War the movement was materially curtailed. Imports into the United Kingdom, one of the large importing countries, fell from about 43 million pounds in 1915 to about 17 million pounds in 1917. Imports into the United States fell from 31 million pounds in 1915 to 5½ million in 1917. This includes dates for both domestic consumption and for re-exports. Import value per pound rose from 1.6 cents per pound in 1915 to 4.3 cents per pound in 1917.

The conditions during the present war are not exactly the same as in the last war. For that reason, we cannot safely assume that the results will be identical. For example, warring nations during the present conflict are exercising a greater centralization of control in determining international trade policies. The flow of the international trade would depend on these policies. Up to the present time evidently there has been little if any interference with dates coming to the United States. During the last few months of the year when imports are normally highest, they were somewhat higher in 1939 than they were in 1938.

PRICES

Prices are influenced by changes in the supply and demand conditions. There has been a close relationship between consumer income in the United States, supplies in California, and average prices to growers in California. Farm prices in California between 1928 and 1939 varied from 13.1 cents per pound to 2 cents per pound. During this period, there has been little relation between the trend in the California farm price and the import value per pound of dried dates.